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Trucks

Are on Their Way to Best Year in History; Used Car Sales Rise as New Cars Pass Peak

Retail activity in the motor industry continues around the best level of the year. While new car sales give evidence of having reached a peak, the used car business is still climbing at a good rate and is likely to continue on the upgrade for some weeks. Despite the continued strength of the new car market, which is bringing dealers great numbers of used vehicles, demand for the latter now has increased to the point where sales are running in excess of the trade-in rate and stocks are beginning to lighten.

The big pickup in used car business came about on scheduled time following the usual seasonal pattern. This department of the automobile business requires mild, sunny weather to flourish at its best, and for that reason sales reach a peak somewhat later than with new cars. The good selling season, however, extends throughout the entire summer and sometimes well into fall. With the good start that has been made, and the prospects for an active used car demand this summer, little difficulty is expected in liquidating the admittedly high dealer inventories that have accumulated before the next model season again piles up stocks.

"The used car business is very free," reports the sales chief of one of the big companies. "In fact, there is a shortage of used vehicles in some spots." His dealers have well under 30 days' supply on hand based on current rate of sales. Several other leading companies report about the same inventory situation.

There is a good chance that July may be the peak for used car sales in view of the stimulus expected from the veterans' bonus money which then will be in circulation, together with further probable releases of other Government funds. Some believe that these factors are likely to distort the seasonal trend for new cars also, sustaining summer business on a better than normal seasonal level. One thing seems reasonably certain: The motor companies are not likely to be faced with a clean-up problem before entering the next model season. Demand for current lines has been consistently higher than the manufacturers had planned for, and this late in the season some are still struggling with good-sized batches of unfilled orders. Some of these orders are believed to represent dealers' anticipation of bonus business.

From all indications the truck industry is going to enjoy the best year of its history. Although final data are not complete for the first four months, it is quite evident that this period will not only exceed the same period of 1935 but will pass the first four months of 1929 by a very comfortable margin.

During the first third of the calendar year's sales, as indicated by new truck registrations, approximately 198,500 new commercial vehicles were retailed, as against 165,204 for the like period of 1929, which was the peak year of the industry. This is an indicated gain of about 20 per cent, or approximately 33,000 units. New registrations for April amounted to 62,000 units, an all-time high for any April or for any other month since the beginning of official registration figures in 1926. While this figure for the month is an estimate, enough complete returns have come in to indicate that

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Research

Laboratory Facilities To Be Expanded by GM

The research laboratory section of General Motors is expanding its shop facilities for experimental development and tool manufacture into part of the Cadillac-La Salle plant in Detroit, according to an announcement by the corporation. Enlargement of the

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This Week

Wage

Scale of Chrysler Shop Employees Raised 5 Per Cent, Effective June 1

The Chrysler Corp. announced this week an increased wage scale for its shop employees, to go into effect June 1. The increases will vary for the different classifications of labor, but the new scale will represent an average increase of 5 per cent and will cost the company from five to six million dollars a year.

"In March, 1934, the hourly rated employees received a further increase of 10 per cent," said an announcement by K. T. Keller, the president, after mentioning the 1933 increase. "This brought hourly rates back to a level slightly higher than prevailed prior to the beginning of the depression in 1929.

"In March, 1934, the company also began a gradual change from piece rate and a group bonus to hourly rate payment, which was completed that year.

"In April of 1935, at the time the

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Motor Union Merger

Independents to Vote on Affiliation with A. F. of L. International

Amalgamation of the two leading independent unions in the motor industry with the United Automobile Workers International Union of the A. F. of L. was expected to be consummated this week. Both the Automotive Industrial Workers Association and the Associated Automobile Workers of America had called special meetings for Friday evening, May 22, for final vote and to ratify terms of merger agreed upon by representatives. Leaders of both organizations predicted a vote favorable to consolidation. The independent unions will be permitted to come in as a body with no charter nor individual initiation fee.

Action of the A.A.W.A. involves only the Hudson local, which is the largest local in that organization. A fair-sized membership is claimed in Pontiac and Lansing plants, but, apparently lacking interest, these locals sent no representatives to preliminary merger negotiations in Detroit. Hence, a decision by the A.A.W.A. workers at the Hudson plant to come under the U.A.W. banner will not wipe out the independent union unless such loss of strength leads to disintegration.

"It will be the policy of our union when dealing with employers," said Homer Martin, newly elected president of the U.A.W., "to do everything reasonably within our power to make strikes unnecessary. We shall prefer the council table to the picket line. We shall make every reasonable effort to meet the employers half-way. But let it be understood that our union can and will fight to the bitter end against any employer who refuses to deal with the U.A.W. in collective bargaining.

"Let the world understand that the U.A.W. seeks peace, not war," he added, "but there will be no peace until the organized might of automobile labor meets around the council table with the employers, arriving together at an agreement."

Edward J. Galer

Edward J. Galer, 41, and for three years office manager of Pontiac Motor Co., died Sunday night in St. Joseph's Mercy Hospital, Pontiac, after an illness of six days. Death was caused by pneumonia. Burial was at Asheville, N. C.

Mr. Galer had been an employee of Pontiac Motor Co. for 17 years.

ASI Joint Show to Be Held In Chicago, Dec. 9 to 14

The joint operating committee for the Automotive Service Industries show announces to the after-market industry that it is advised by John Muller, W. F. Wilkerson and Frend Wacker, respective presidents of the National Standard Parts Association, Motor and Equipment Wholesalers Association and Motor and Equipment Manufacturers Association that the show scheduled to be held in Chicago Dec. 9 to 14 will be jointly sponsored by the three associations as heretofore.

Work on the show program is proceeding in orderly fashion and the committee will release information regarding its activities as fast as plans are consummated.

W. Zwiener
president of the Hupp Motor Car Co.

German Car Wins

Auto-Union Averages 129 m.p.h. At 325-mi. Tripoli Course

An average of 129.6 m.p.h. was maintained by Achille Varzi, driving a 16-cylinder German Auto-Union, in the Tripoli 325-mile road race. This is the highest average ever attained in any automobile race in Europe. Hans Stueck finished second in a similar car, five seconds behind his team mate. Fagioli and Caracciola in Mercedes cars were third and fourth. Varzi also put up the fastest lap, at an average of 141.28 m.p.h.

The Auto-Union racing car is fitted with a 16-cylinder rear engine of 75 by 85 mm. bore and stroke (2.95 by 3.34 in., 366 cu. in.). The highest speed this car has ever attained is 194.13 m.p.h., when it broke world's records on the super highway near Frankfort. The Tripoli race is run under the free-for-all rule, which enables Auto-Union to make use of a bigger engine than is employed when races are run under the maximum weight rule. This race proved that tires have not kept pace with mechanical progress, for on this fast course Auto-Union, Mercedes and Alfa Romeo all ran into tire trouble whenever full power was applied. Given better tires, the average speed could have been increased on this course.

It is probable that the Auto-Union, Mercedes and Alfa Romeo cars which ran in this race will compete at Mineola on Oct. 12.

Competition or Regulation

America Must Decide Between These Two, Says Sloan, Addressing Los Angeles Commerce Chamber

"America must decide between two opposing principles of industrial operation: competition, on the one hand, or regulation and ultimately regimentation by the government, on the other," said Alfred P. Sloan, Jr., president of General Motors, in an address at the 48th annual banquet of the Los Angeles Chamber of Commerce Friday evening. Mr. Sloan had taken as his subject: "Shall We Have More—or Less?"

To the question: "Do we want more—or less?" Mr. Sloan said there can be no doubt but that everybody wants more—and nobody wants less. To the question: "Is it possible to have more?" he replied: "More things for more people has been the objective of industry ever since its very inception."

Only our thinking has changed, in the opinion of Mr. Sloan. "Today the majority of our people," he said, "our leaders of government and far too many within industry itself appear to be convinced that we now have a permanent surplus of workers in relation to our ability to consume their products, particularly bearing in mind the continual progress of mechanization. . . . They argue that the amount of work available today cannot, to a sufficient degree, be increased, therefore that we must find the best way to divide up what exists so that all may have at least something."

Attacking the opinions of those who are urging stabilization so that, as they think, depressions and booms may be minimized, Mr. Sloan said: "But in this sense 'stabilization' means regulation, and regulation ultimately means regimentation. Regulation of industry is only possible by government acting in the interests of the worker, the consumer and ownership. But government must act through bureaucracy."

Mr. Sloan referred to the record of the automotive industry—to the two principles that it has always rigidly adhered to, and today has greater faith in than ever. First: it has always moved toward a greater dollar value. Second: it has always believed, and acted on the belief, that its own progress and the greatest urge for accomplishment come from the influence of free competition and the exercise of individual initiative.

"One thing is perfectly evident to-

day," he continued. "Those who have followed the practice of lowering the cost of goods and services are the ones who show the smallest amount of unemployment and have therefore made the most progress toward recovery. On the other hand, those who have followed, to some extent, the principle of stabilization, have progressed the least and are, today, still the most depressed."

Mr. Sloan concluded by pointing out certain economic principles that he believes industry should follow in working toward our objective:

"First, I urge continuing to move for a constant lowering of costs and prices.

"Second, industry should accept competition as the best instrumentality for regulating industry's delicate relationships.

"Third, industry should strive for a more economic balance of national income through policies affecting the relationships of the wage scale, the hours of employment, the price level and the profits resulting from industry's productivity."

Mr. Sloan and a group of General Motors officials are visiting Los Angeles in connection with the dedication on Saturday, May 23, of the corporation's new assembly plant located in that city.

Car Prices Rise in Canada

Consumer Benefits Expected from Lower Tariff Fail to Result and Investigation Is Demanded

The reactions which follow upon a price structure going up when it was intended and expected to go down are being experienced by certain Liberal Parliament members at Ottawa, Ont., over the price of motor cars. Feelings were vented at a caucus of Government supporters this week. In the budget on May 1, one duty, the minimum of 17½ per cent, was substituted for the three different duties heretofore prevailing, and certain changes were made in the sales tax. The fact-findings of the Tariff Board were followed.

The design was to cheapen the lower range of cars, and, at the same time, perpetuate the industry, which was given concessions on machinery and parts. Some Liberal members, after telephoning around Ottawa, are persuaded that prices have gone up, not down, as expected. Consequently, as budget details have yet to be considered, a survey of prices throughout the country is advocated. If the price level has been elevated, a certain section will demand a more extensive cut in the duty when the budget measure reaches the appropriate stage to do it.

Ninety-eight per cent of all new cars bought in Montreal will be increased in price as a result of the new budget in Ottawa, according to local dealers. This applies to all cars costing less than $1,500 delivered there. The odd 2 per cent sold in the city at prices higher than this may show a reduction. A check-up by the correspondent of AUTOMOTIVE INDUSTRIES showed that dealers handling the principal and most popular automobiles had already received notices of increased prices. These prices ranged from $5 on the cheapest models to $26 on cars up to $1,500.

Motor makers are still deep in cost and price figures, and most car buyers are expected to pay more for their new 1936 machines. Big cars may be reduced, but no prices were available as yet. The reason for the increase is, of course, the jump in the sales tax from 6 to 8 per cent. The smallest increase seems to be in the Chevrolet, which reports a standard coach on sale complete at Toronto, Ont., with license and all taxes paid, at $817, an increase of three dollars. The master coach, on the same basis, is higher by six dollars at $953. Ford dealers in the city of Toronto report a standard coach at $811, an increase of $14, while a Fordor touring sedan complete with trunk is quoted at $978, an increase of $19.

Other price increases reported for Toronto include: Oldsmobile 6 coach, up $16 to $1,161; Oldsmobile 8, up $27 to $1,397; Dodge two-door touring sedan, up $18 to $955. The increase in Dodge and DeSoto models ranges from $15 to $35. Plymouth is reported higher by a like amount, with Chrysler increases ranging from $25 to $45. Nash cars around the $1,000 mark are up about $25. One important result anticipated from the new tariff is that car prices will be more generally quoted on a "factory delivered" basis, exclusive of freight, license and Government taxes. In this way the industry hopes to make car buyers more "tax conscious."

NADA Dealer Returns

Analysis Shows Distribution Of 1935 Car Sale Reports

The National Automobile Dealers Association has issued an analysis showing the distribution of dealers whose returns formed the basis of the data on 1935 car selling trends, published in AUTOMOTIVE INDUSTRIES last week. The distribution tables follow:

Distribution of Returns (1935)

Population

1,000,000 and up	47	(3.5%)
500,000-1,000,000	49	(3.7%)
250,000-500,000	86	(6.5%)
100,000-250,000	96	(7.2%)
50,000-100,000	100	(7.5%)
25,000-50,000	126	(9.5%)
10,000-25,000	239	(18.0%)
5,000-10,000	156	(11.8%)
2,500-5,000	107	(8.1%)
Less than 2,500	321	(24.2%)
Total	1327	(100.0%)

Dealer Groups
According to New Car Sales for Year

1-10 sales	65	(4.9%)
11-20 sales	65	(4.9%)
21-50 sales	211	(15.9%)
51-75 sales	130	(9.8%)
76-100 sales	127	(9.6%)
101-200 sales	358	(27.0%)
201-500 sales	284	(21.4%)
501-1,000 sales	77	(5.8%)
Over 1,000 sales	10	(0.7%)
Total	1327	(100.0%)

Major New Car Line Handled

Chrysler	321	(24.2%)
Ford	345	(26.0%)
General Motors	498	(37.5%)
Other Makes	163	(12.3%)
Total	1327	(100.0%)

Sovfoto

The first automobile for children of the U.S.S.R. has been made by the Central Auto Laboratory in Moscow. Designed by Zimelev and Lukin, it is powered by a 3 hp. engine, weighs 440 lb., and is said to have a speed of 30 m.p.h. on good roads.

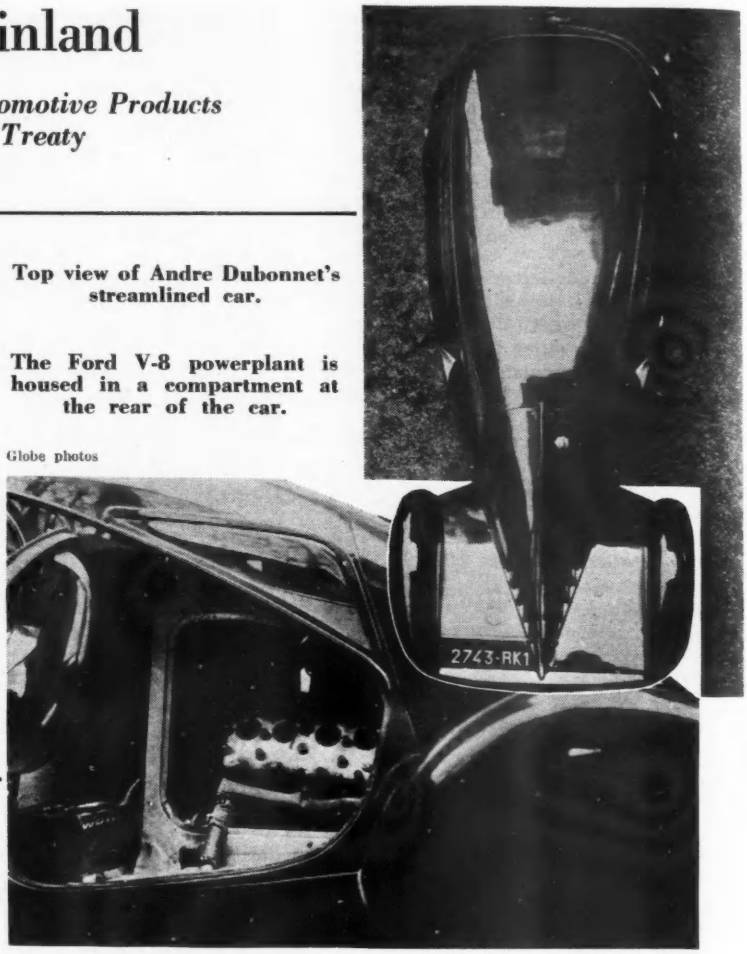
Reciprocity with Finland

Present Low Tariff Rates on U. S. Automotive Products Guaranteed for Duration of Treaty

Passenger cars, motor trucks and parts, gasoline and automobile tires, including inner tubes, are among products exempted from ordinary customs duties in excess of those specifically set forth in the Finnish-American reciprocal tariff agreement which has just been negotiated.

These articles also are made exempt from all other duties, taxes, fees, charges or exactions, imposed in excess of those in effect on the day of signature of the agreement or thereafter. The provision does not apply to quantitative restrictions that may be adopted to regulate the production, market supply or prices of like domestic articles, or tending to increase the labor costs of production of the affected articles. Whenever the government of either country proposes to establish or change any restriction on the articles included in the terms of the provisions, it will be required to give written notice of such contemplated action to the other government. If agreement is not reached within 30 days after receipt of the notice, the agreement may be terminated in its entirety on 30 days' written notice.

The agreement is to become effective on the thirtieth day following proclamation by the President of the United States and approval by the President of Finland, and will remain in force for three years subject to certain provisions as to the right of termination in the meantime.



Top view of Andre Dubonnet's streamlined car.

The Ford V-8 powerplant is housed in a compartment at the rear of the car.

Globe photos

British Firm Obtains Rights For Hydraulic Transmission

British rights for the Sensaud De Lavaud hydraulic transmission, now being demonstrated in the United States by André Dubonnet, have been taken up by a group in which the Riley Co., of Coventry, is dominant. Austin, one of the two biggest manufacturers in England, is negotiating for manufacturing rights.

Arrangements are now being completed in France for this transmission to be marketed as a replacement for Ford V-8 cars. Taking the place of the ordinary Ford transmission, the changeover can be effected in half a day. Fiat of Italy has taken an option.

Financing Shows Steady Gains

March Wholesale and Retail Figures Well Over February and Year Ago, While 1st Quarter Outlay is High

Closely following the rise in sales figures, retail automobile financing in March showed marked advances while wholesale volume showed similar gains, according to figures released by the Bureau of the Census, Department of Commerce. The dollar volume of retail financing totaled $150,820,930 representing a gain of 65 per cent over February and 51 per cent over March a year ago. The wholesale volume, amounting to $158,555,634, made a gain of 35 per cent over the February figure and 6 per cent over March, 1935.

Figures for the first quarter show a gain of 47 per cent in retail and 13 per cent in the wholesale division. The average amount of retail financing on all cars for the three month period has increased from $371 per car in 1935 to $394 in 1936, and the average amount per new car has increased from $537 to $569.

ICC Orders Railroad Report

The Interstate Commerce Commission has ordered all Class I railways to furnish information regarding their investments in highway motor vehicle enterprises for the carriage of persons or property. Returns in compliance with this order are to be filed with the commission on or before July 1 next.

	Wholesale Financing Volume in Dollars	RETAIL FINANCING											
		TOTAL			NEW CARS			USED CARS			UNCLASSIFIED		
		Number of Cars	Total Amount	Per Car	Number of Cars	Total Amount	Per Car	Number of Cars	Total Amount	Per Car	Number of Cars	Total Amount	Per Car
March 1936.......	$158,555,634	378,230	$150,820,930	$399	172,388	$97,778,634	$567	203,523	$52,235,748	$257	2,319	$806,548	$348
February 1936....	117,133,986	232,106	91,671,545	395	98,953	57,038,172	576	131,666	34,128,106	259	1,487	505,267	340
March 1935.......	149,057,165	270,099	100,076,895	371	120,103	63,953,950	532	144,843	34,267,163	237	5,153	1,855,782	360
3 Months 1936....	398,885,508	852,780	335,807,686	394	374,511	213,016,490	569	472,969	120,981,818	256	5,300	1,809,378	341
3 Months 1935....	353,773,472	616,759	229,055,927	371	271,137	145,559,491	537	333,314	79,025,190	237	12,308	4,471,246	363

Streamlining Adds Stability

Road Tests of Andreau Designed Experimental Car Also Give Greatly Increased Speed and Economy

Practical results of a surprising nature have been obtained by streamlining, according to the principles evolved by M. Jean Andreau, French engineer and ballistic expert. A speed of 112 m.p.h. was obtained on the highway with a car having an eight-cylinder engine of 90 hp., and, at a sustained speed of 62 m.p.h., the fuel mileage was 22 to the American gallon.

These road tests, which confirmed the laboratory results, were carried out on behalf of a French automobile manufacturer with a standard chassis having a forward engine and a rear drive; no mechanical changes were allowed, and it was stipulated that the internal body dimensions should be equivalent to those of the standard 5-passenger car.

Some of the principles evolved by Andreau were incorporated in the Dubonnet car now in America, but the latest test job shows a considerable improvement. The coefficient of air resistance of the Dubonnet car is 0.00102, while on the Andreau job this has been reduced to 0.00085. By making certain changes in the chassis lay-out, Andreau claims that he can reduce the coefficient for a full sized five-passenger automobile to 0.00076 or 0.00072, and for a three-passenger sports model to 0.00046. These results have been obtained on models tested in the Chausson laboratory at Paris and in the Aerotechnique Institute at Saint Cyr, and have been confirmed by practical tests on the highway.

Starting with a coefficient of resistance of 0.00288 for a plane surface, Andreau shows by his experiments that this can be reduced to a minimum of 0.000282 for a specially designed automobile. The following are some of the figures obtained:

	Air-Resistance Coefficient
Plane surface	0.00287
Delage sedan	0.00218
Citroen rear drive	0.00228
Citroen front drive	0.00213
Maybach	0.00154
Dubonnet	0.00102
Andreau experimental car	0.00085
Immediate future	0.00064-0.00072
Sports 3-passenger	0.00046
Minimum obtainable	0.00028

The experimental job, which at present has a speed of 112 m.p.h. and a coefficient of air resistance of 0.00085 will eventually be put into production. As the speed obtainable is too high under present road conditions, the eight-cylinder engine is being taken out and replaced by a four-cylinder model of 50 hp. A feature of this car, confirmed by all who have driven it, is that the higher the speed the greater the stability. Up to 60 m.p.h. there is no perceptible difference compared with an ordinary car of the same make, but beyond this speed the sense of stability increases in a marked degree. The stability with a side wind is incomparably better.

An increase of 60 per cent in average speed and a decrease of 37 per cent in gasoline consumption is possible by scientific streamlining, declares Andreau. He claims that the speed of the Auto-Union racing car, which is one of the most advanced European designs, could be increased by 60 m.p.h. by his scientific streamlining and that acceleration from 120 m.p.h. could be improved by 40 per cent. With a cheap two-seater car as proposed by the French Society of Automobile Engineers, speeds of 43, 62 and 75 m.p.h. would be obtainable, utilizing engines of 5, 9 and 13 hp., with fuel mileages of 78, 52 and 45 per gallon. These results are arrived at on the assumption that the car weighs 1540 lbs. in running order.

Bendix Acquires Interest In Jaeger Watch Company

The Bendix Aviation Corp. has purchased a substantial interest in the Jaeger Watch Co. of New York, it was announced last week. The development is to assure cooperation in design and manufacture of precision instruments between Jaeger, New York, the Pioneer Instrument Co., a wholly-owned Bendix subsidiary, and the Jaeger Co. of France and Switzerland, suppliers of precision instruments to the French army and to European automobile manufacturers.

Edgar L. Vail, president and general manager of the Jaeger Watch Co. of New York since its inception, will continue in that position. Both Mr. Vail and the European Jaeger company will retain their interests in Jaeger, New York.

George L. Sexton Forms Long Hill Laboratories

The Long Hill Laboratories has been formed by George L. Sexton, until recently vice-president and general manager of Bond Electric Corp. Mr. Sexton is president and general manager of the new company and offices will be located at the plant in Long Hill, Conn., and New York City.

The new organization will specialize in the manufacture of a number of items for the automotive field.

Wages at Chrysler Raised

(*Continued from page* 713)

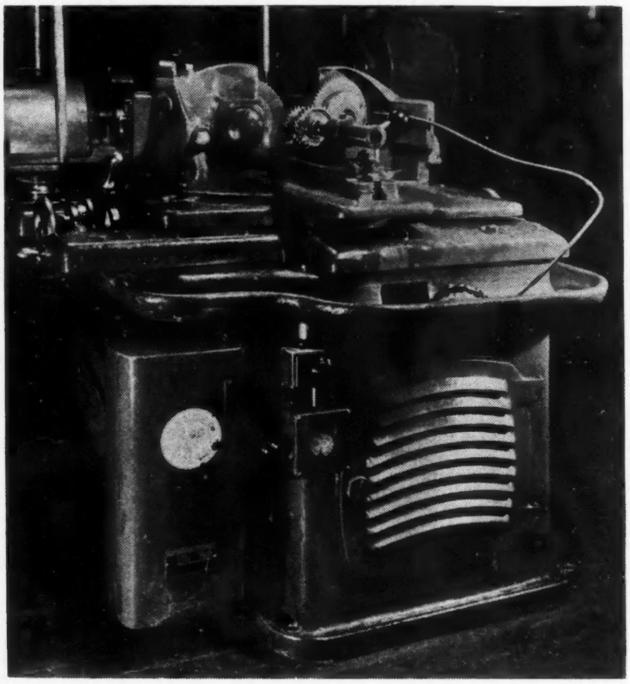
existing rate classifications were established, an adjustment upward was made in the rates of a great many employees in each classification. In September, 1935, the minimum rates for male employees were increased to 60 cents per hour and the minimum rates for female employees were increased to 50 cents per hour, except for male and female learners and apprentices.

"With improved conditions this year, the corporation found it possible, on Feb. 14, to make a special disbursement to all of its employees amounting to $2,300,000.

"It was also felt that conditions warranted the adoption at this time of a higher scale of wages than the existing wage rates."

International News photo

Passengers embark for a transcontinental trip on the new All-American sleeper bus. It is equipped with radio, has dressing and wash-room facilities and a refrigerator where light lunches may be kept.



Ford transmission gears are lapped after heat treatment to assure the smooth and accurate tooth profile so essential in the production of today's silent transmissions. Lapping of Ford gears is done on a battery of ingenious machines in which the lapping gears are cut from abrasive wheels, thus eliminating the need for lapping compounds required when cast iron gears are used.

I.C.C. Investigates Keeshin

Details of Financing of Huge Motor Transport Concern Revealed in Chicago Inquiry

Two hearings held in Chicago this week by the Motor Carrier Division of the Interstate Commerce Commission, may influence the national trucking situation. Close observers of the trucking industry regard them as the most important sessions that have been held this year.

Through testimony given by Harry M. Wyatt, attorney and accountant, every detail concerning the deal last August between Mr. Keeshin and Lehman Brothers, New York investment house, was revealed. Mr. Wyatt represented both sides in that transaction, and from the witness stand he told voluntarily under direct and cross-examination the facts as to the organization of Keeshin Transcontinental after the stock in Keeshin Motor Express had been surrendered.

He gave testimony also on the details of the "voting trust" to which both Mr. Keeshin and Lehman Brothers surrendered 1500 shares of stock each, with the further provision that when stock franchises are exercised in the future the shares in the "voting trust" are to be increased to give always an equilibrium of holdings.

Mr. Wyatt testified that John Hertz, former Chicago taxicab magnate, has no stock personally in the company—"not one single share," he said. On this point, attorneys for railroads subjected him to strenuous cross-examination, declaring what they had heard as to John Hertz' extensive holdings. It was put into the records that several of the trust funds which Mr. Hertz, who is a partner in Lehman Brothers, has set aside for members of his family have purchased approximately $150,000 worth of stock in the Keeshin Transcontinental Company from the voting trust at $100 par value, but that he personally holds more.

Mr. Wyatt related also the details surrounding Mr. Keeshin's surrender f his stock in Keeshin Motor Express and of the blocks of stock which he received in their stead in Keeshin Transcontinental.

Facts as to other companies and lines which are affiliated with the gigantic Keeshin organization were told by C. R. Olson, vice-president in charge of operations of the entire system. Mr. Olson gave one of the most straightforward pieces of testimony that has ever been given before an I.C.C. hearing on trucking affairs.

Off the record, his testimony was commented on by various persons who had filled the hearing room. He reviewed the acquisitions of various small trucking concerns from time to time and of their mergers and final abolishment as separate identities after being combined with other companies and lines which go to make up the general organization. Without revealing any of Mr. Keeshin's plans for future expansion, he let it be made a part of the records that Mr. Keeshin has always been an advocate of Federal regulation of the trucking industry, and explained that a number of things which it is expected will be done in the near future are being held in abeyance until such time as the Motor Carrier Division can begin to function as it hopes.

Shippers from Iowa who are being served by the National concern testified that the service which they have been getting since Feb. 9, the date that the contract to purchase between the National and Keeshin companies was made subject to I.C.C. approval, has been materially improved. Other witnesses from the Keeshin organization included numerous persons from the accounting, traffic and tariff departments.

At one of the hearings, with J. G. Cooper, Secretary of Finance, as examiner, the application of Keeshin Transcontinental Freight Lines, Inc., to acquire through purchase the properties and rights of Charles T. Durand, owner of the National Transfer & Storage

JOHN MEHRING, who has been with the Ethyl Gasoline Corp. since 1924, has been appointed treasurer of the corporation.

W. S. KNUDSEN was elected a director of Yellow Truck and Coach Mfg. Co. at the annual stockholders' meeting. He succeeds Paul W. Seiler.

BURDETTE S. WRIGHT has been elected president of the Curtiss Aeroplane and Motor Co., a subsidiary of Curtiss-Wright Corp. Mr. Wright has been associated with the company since his resignation from the army in January, 1928.

HERMAN ALBERTINE and **B. L. HOFFMAN** have been added to the board of directors of the Rogers Products Co., Inc., of Jersey City, N. J. Mr. Albertine has been head of the engineering department and Mr. Hoffman is in charge of financial operations.

W. R. RAMSAUR has been appointed chief engineer of the Young Radiator Co., according to an announcement by F. M. Young, president.

V. C. YOUNG has joined the Wilcox-Rich Corp., division of Eaton Mfg. Co. as sales engineer. He was formerly with the International-Plainfield Motor Co. as testing engineer.

ARTHUR E. TONGUE has been appointed director of advertising and sales promotion for the Chrysler sales division of the Chrysler Corp. He comes to Chrysler with 19 years of varied experience in the advertising departments of Hyatt Roller Bearing, General Motors, and Underwood-Elliott-Fisher.

PHIL ROZELLE, formerly special representative for the Auburn Automobile Co., has been made general manager of the company's factory retail branches at Auburn, Ft. Wayne, Indianapolis and Connersville, Ind.

F. E. PHILLIPS, export sales manager of the Gemmer Manufacturing Co., expects to sail on the Champlain May 23 for a month's business visit in Europe.

Co., of Marshalltown, Ia., was taken up. This hearing resolved itself into a complete unveiling of the Keeshin financial structure. And with attorneys and other representatives of rival trucking concerns and of several of the class I railroads present, strictest attention was given to the testimony.

Another hearing was by invitation. It was conducted by John L. Rogers, director of the Motor Carrier Division, and invitations had been sent out to representative bureaus in the central freight district, to the leading independent operators, publishing agents, Keeshin lines and the A.T.A.

The purpose of this session was to take up the tariffs which had been filed with the I.C.C. and which showed such wide differences as to bring confusion to the I.C.C. offices. Classifications of operators was another matter that was taken up with the thought of making disputed points clearer in the minds of many operators.

AMA Urges Republicans To Adopt Reciprocity

The Automobile Manufacturers' Association will petition delegates of the Republican National Convention to include in this year's platform a plank endorsing the reciprocal trade treaty program and the most-favored-nation principle, it was decided by the directors of the association on May 12.

In announcing the decision before a joint committee of several Republican organizations in New York last week, Edgar W. Smith, vice-president of the General Motors Export Corp., pointed out that the A.M.A. had taken the step because it believed that the tariff question should become non-partisan and taken out of politics.

Kettering Honored

Talks on Research at Medal Award; Sperry Is also Recipient

A plea that corporations should put their research activities on an actuarial basis and regard them as insurance against "ignorance of what's going on and against failure to recognize the fact that we must progress," was made by Charles F. Kettering, vice-president of General Motors Corp., speaking in Philadelphia, May 20. The occasion followed the presentation of the Franklin Medal by the Franklin Institute to Mr. Kettering for his "significant and timely contributions to the science of automotive engineering."

Much grief in research can be credited to modern accounting, Mr. Kettering continued, for excellent as the profit and loss system may be in nearly all branches of business, it does not work in the research laboratory. The period that too often exists between the conception of a new idea and the beginning of its commercial production, Mr. Kettering termed the "shirt-losing zone."

The second recipient of the Franklin Medal was Dr. Frank B. Jewitt, founder and president of Bell Telephone Laboratories, Inc., and to Elmer A. Sperry, Jr., vice-president of Sperry Products, Inc., was awarded the Longstreth Medal for his work in the development of gyroscopic flying instruments.

Ringless Piston Available

A ringless piston, for which commercial possibilities are claimed, has been exhibited to the staff of AUTOMOTIVE INDUSTRIES by the inventor and his associates. License to manufacture the piston is available on a non-exclusive basis. Inquiries concerning it will be forwarded if sent in care of AUTOMOTIVE INDUSTRIES.

Automotive Metal Markets

Threat of Higher Third Quarter Prices for Steel Has Not Hastened Motor Buying

With the exception of automobile sheets, which must be ordered a month or more in advance to insure delivery on time, none of the business coming to rolling mills from motor car manufacturers and parts makers represents other than current requirements. Nowhere is there in evidence any indication of protective covering on the part of automotive consumers.

If the trial balloon, carrying intimation of higher third quarter prices, which was recently sent up, was intended chiefly to quicken the buying pace at present prices, it has so far proved utterly ineffective. In fact, parts makers are very cautious in covering June requirements and strip mills report a slight easing off in demand from that source. On the whole, however, automotive consumption of steel is well maintained.

The American Iron and Steel Institute reports even an increase in the rate of ingot production, which this week employs 69.4 per cent of capacity, compared with 69.1 per cent in the preceding week. In part, this gain may be due to the stocking of semi-finished steel by some mills. Finishing mills continue to operate very much along unchanged rates. A slight dip in ingot operations at Detroit is primarily due to one of the Ford furnaces being temporarily out of commission for relining.

While the rule that buyers, to be entitled to quantity discounts, must accept shipment within one and the same calendar week is being adhered to rigidly in some lines, the convenience of producers of some descriptions calls for a more literal interpretation of the rule. To keep all of their customers satisfied, sheet mills frequently have to resort to apportioning their from day-to-day output, and too rigid compliance with the calendar-week rule is more of a burden to them than to the buyer.

Pig Iron—The Supreme Court's decision, declaring the Guffey coal law unconstitutional, is accepted in the pig iron market as making for greater stability of pig iron prices. The present movement of pig iron into automotive foundries is largely of a routine character, with prices unaltered.

Aluminum—Several secondary grades of alloys are quoted ½ cent per pound lower; so No. 12 alloy, remelted, is now selling at 16 @ 17½ cents, compared with 16½ to 18 cents earlier in the month. Primary aluminum prices remain unchanged.

Copper—The market is still waiting for another buying movement, such as set in last month, when buyers were given a 48-hour option to buy before the advance. With the producers' price held steady at 9½ cents, delivered Connecticut, the "outside" market is now quoted at slightly under 9⅜ cents.

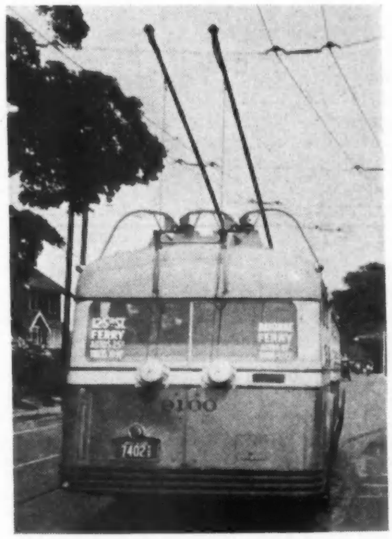
Tin—Shipments of Straits tin during the first half of May were exceedingly heavy, being more than 5000 tons. The general impression in the trade is that, when the International Tin Committee meets on May 26, the present export quota of 85 per cent will be allowed to continue unchanged. The Bolivian coup d'etat has had no effect on the market. Spot Straits sold early this week at 46¾ cents, ½ cent down from the preceding week's close.

Lead—Quiet and unchanged.

Zinc—Steady and unchanged.

C. H. Bull Co. to Represent Young Radiator on West Coast

The Young Radiator Co., Racine, Wis., has recently appointed the C. H. Bull Co., 115 Tenth St., San Francisco, Calif., to handle the sales of Young heavy duty radiators, oil coolers, heat exchangers, and air conditioning equipment on the West Coast.



One of the new all-service buses of the Public Service Coordinated Transport of New Jersey leaves the trolley wires to operate under its own power as a gas-electric vehicle. An order for 75 of these buses has been placed with the General Motors Truck Co.

Business in Brief

Written by the Guaranty Trust Co., New York, exclusively for AUTOMOTIVE INDUSTRIES

The defeat of the Frazier-Lemke inflationary measure has apparently had a beneficial influence on business. Despite the usual seasonal decline in many branches of business, activity last week held up well and was only slightly below the six-year peak reached a few weeks ago. Wholesale business was in larger volume; and, in view of the prospects for a heavy vacation and travel season and the payment of the soldiers' bonus, a high level of operations in the distributive trades is anticipated.

Carloadings Steady

Railway freight loadings during the week ended May 9 amounted to 668,935 cars, which marks a drop of 2219 cars below those in the preceding week, but an increase of 93,915 cars above those a year ago, and a rise of 66,137 cars above those two years ago.

Food Costs Firm

Retail food costs during the two weeks ended April 21 increased by 1.1 per cent according to Bureau of Labor Statistics. This increase was largely due to a rise in the prices of fresh vegetables. The current index stands at 79.7, based on the 1923-25 average as 100, as against 78.9 two weeks earlier and 81.9 a year ago.

Chain Store Sales Up 10%

Sales of 27 store chains, including two mail order houses, during April were about 10.2 per cent above those in the corresponding period last year. Sales of these same store chains during the first four months of this year were about 8.1 per cent above those a year ago.

Electric Output Higher

Production of electricity by the electric light and power industry in the United States during the week ended May 9 was slightly above that in the preceding week but showed a gain of 14.5 per cent above that in the corresponding period last year.

Lumber Shipments Heavy

Lumber production during the week ended May 2 was 66 per cent of the 1929 weekly average and was slightly below the volume in each of the three weeks preceding. New business was 4 per cent below the weekly average for April. Shipments were the heaviest for any week since May, 1931, with the exception of the pre-strike week ended May 4, 1935.

Fisher's Index

Professor Fisher's index of wholesale commodity prices for the week ended May 16 stood at 81.0, as compared with 81.6 the week before and 82.2 two weeks before. The current index is the lowest reported since April, 1935, and compares with this year's high of 84.4 recorded in the second week of January.

Federal Reserve Statement

The consolidated statement of the Federal Reserve banks for the week ended May 13 showed no changes in holdings of discounted bills, government securities, and bills bought in the open market. Money in circulation declined $24,000,000, and the monetary gold stock increased $54,000,000.

Truck Production Best Ever

(*Continued from page* 713)

final figures will be within a very close margin of this estimate. This is about a 20 per cent gain over the 51,817 units registered in March and 35 per cent over April, 1935.

All makes of trucks in the domestic market show substantial gains over the same period last year with the exception of Ford, Reo and Sterling. Ford shows a slight loss at the end of the first three months of 3.1 per cent. Four makes of trucks, Chevrolet, Ford, Dodge and International, did 92 per cent of the total business during the first three months of the year.

While it is rather early to make any prediction as to the total figures for this year, it is safe to say that if sales continue at the present rate for the remainder of the year the total for the year should be in the neighborhood of 620,000 units, topping 1929 by nearly 100,000, or 18 per cent.

Continuation of heavy retail volume experienced since the middle of the first quarter was reflected in sales of the Buick Motor Co. reported for the first 10 days of May. During this period domestic retail deliveries of Buick motor cars totaled 4903 units, comparing with 2100 cars delivered in the corresponding period a year ago, a gain of 2803 sales or 133.5 per cent. The figure compared with 5568 cars delivered during the first 10 days of April and with 3237 cars delivered in the corresponding period of March.

Meanwhile, the company entered the current month with a bank of more than 12,000 unfilled orders, which has remained consistently at this level.

Sales in the first reporting period of May brought total sales of Buick motor cars since the first of the year to 52,437 units, as compared with 23,131 in the corresponding period a year ago. Since their introduction last fall, domestic retail sales of 1936 Buicks aggregated 97,163 units.

Studebaker dealers in the United States delivered 2179 passenger cars and trucks at retail during the first 10 days of May. This compares with 1257 in the corresponding period of 1935—an increase of 73 per cent. Paul G. Hoffman, president of the Studebaker Corp., stated that these retail deliveries are the largest for the first May period since 1929.

Several Government orders for 685 White and Indiana trucks, representing a dollar volume of $1,312,000, have been received from the United States Departments of War and Agriculture within the past week, according to Robert F. Black, president of the White Motor Co. of Cleveland.

G.M. Research Expands

(*Continued from page* 713)

laboratories has been necessitated by lack of space in the present research building adjacent to the General Motors Building.

The expansion does not represent any significant changes in the present Diesel engine development program of General Motors, according to the statement. General Motors controls the Electro-Motive Corp., which has been manufacturing Diesel electric locomotives for railroad powerplants for the past two years.

40 Years Ago

—with the ancestors of AUTOMOTIVE INDUSTRIES

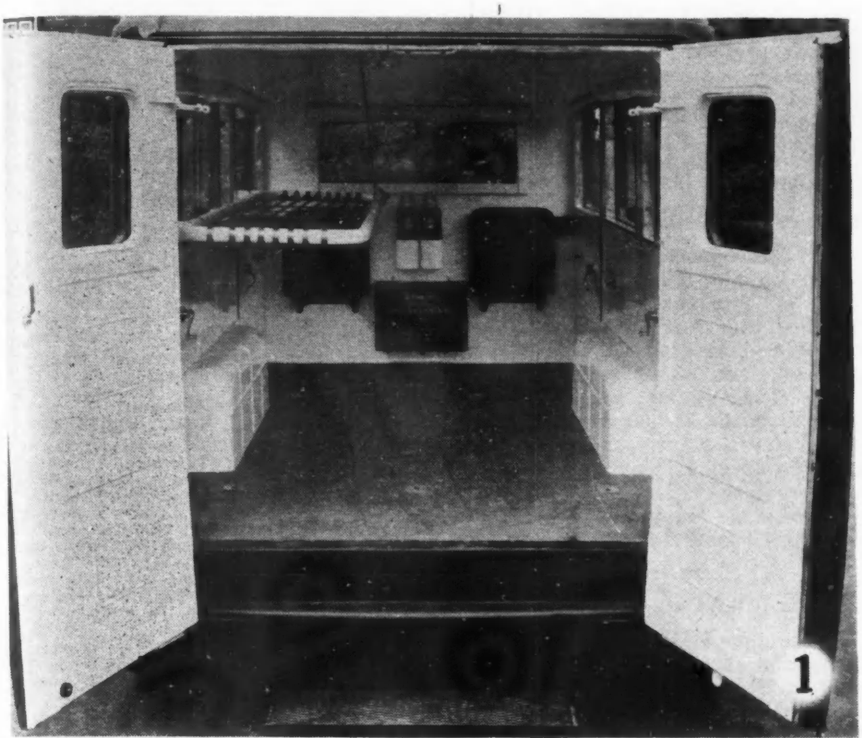
Foreign Notes

The Motor Car Club of London now numbers some 300 members.

Tokyo, Japan, boasts of the possession of one motor carriage, imported from Europe, of course.

The Touring Club of France has established about 200 depots in the provinces for the sale of petroleum of the proper grade for motor use. It has also organized a school for the training of motormen (chauffeurs), and expects to give certificates to about 30 men this season.

—From *The Horseless Age*, May, 1896.



The WORLD on WHEELS

1. Combination light bus and ambulance has been built for use at mines in the Philippine Islands. Used as an ambulance, the patient is placed on the well-sprung carrier at the left and seats for two attendants are at the front of the car.

2. Twelve passengers can be carried when the car is used as a bus.

3. Front view of the bus-ambulance.

Rubber and Tires

April Consumption at New Peak; March Production Lagged

Crude rubber consumption in the United States reached a new high peak in April when 51,897 tons were consumed, according to estimates of the Rubber Manufacturers Association. The figure represents a gain of nearly 22 per cent over the March total and is approximately 17 per cent above April, 1935.

While shipments of pneumatic casings advanced during March, the current labor situation was reflected in the somewhat lower production totals. Estimates show that 3,855,970 units were shipped in March, an increase of 20 per cent over February and 8 per cent below March, 1935. During the same period, production amounted to 3,637,970 casings, representing an increase of but two per cent over February and a decrease of 16 per cent from the March, 1935, figure.

Inventories as of March 31, 1936, were estimated at 9,087,020 compared with 11,675,268 units the previous year.

Borg-Warner Service Branch Will Open in Philadelphia

Within the next few days Borg-Warner Service Parts Co., a division of Borg-Warner Corp., will announce the opening of a new warehouse branch in Philadelphia. Over 6200 sq. ft. of floor space will be used for stocking a complete line of automotive products manufactured by this corporation.

The new branch will be managed by Henry E. Eden, formerly connected with Borg-Warner in New York, and is located at 1418-1424 Melon Street.

All Ford Units Now Have Oil Pressure-Fuel Gauge

The Ford Motor Co. has informed its dealers that it has decided to install the combination oil pressure and fuel gauge on all passenger cars and commercial units where it is not already standard equipment, after May 15, at a cost of $3.25.

Electric Auto-Lite Buys Bay City Rubber Factory

The Electric Auto-Lite Co. is purchasing the Wildman rubber plant at Bay City, Mich., through a new subsidiary to be known as Bay City Manufacturing Co. The company will employ 500 men. Company officials declare they cannot disclose for several days the nature of the products to be made but indicate operations will be ready by Sept. 1, so that new products may go into the new fall models. The Bay City Chamber of Commerce is raising $75,000 to aid in acquiring the new industry.

Koegler Becomes President Of Doehler Die Casting Co.

Franklin J. Koegler has been elected president of the Doehler Die Casting Co., succeeding Herman H. Doehler, who has become chairman of the board, and will have his headquarters in New York.

Headquarters of the company will remain in Toledo and Mr. Doehler, while maintaining general policy direction of the company, will divide his time between Toledo and the three eastern plants. President Koegler will have general administrative charge. L. H. Pillion has been named executive vice-president; Rudolph Bernhard, treasurer; and Fred Knoebel, secretary.

Regular dividends of 87½ cents on $50 par preferred and $1.75 on $100 par preference stocks were declared payable July 1 to holders of record June 20.

Schippert, of Daimler-Benz, Arrives for Visit in U. S.

Dr. C. Schippert, managing director of the Daimler-Benz automobile company, of Stuttgart, arrived on the "Europa" this week for a short visit to the United States. In addition to being the head of the oldest automotive concern in Germany, Dr. Schippert is also president of the Bureau Permanent des Constructeurs d'Automobiles, an international grouping of automobile manufacturers' associations. At one time the Automobile Manufacturers Association was a member of this bureau.

Plan Visits to Wholesalers

Planning a series of visitations to 300 wholesalers and their personnel, a party of Electric Storage Battery Co. sales and advertising executives will leave Philadelphia May 31 for a national tour, accompanied by nine trunks of merchandising material. The party is headed by Frank T. Kalas, assistant general sales manager and includes N. W. Geare, president of the Geare-Marston Co., agency handling the Exide account.

Natural Gasoline (Detailed Statistics) by G. R. Hopkins and E. M. Seeley. Statistical Appendix to the Minerals Year book for 1935. Obtainable from the Superintendent of Documents, Washington, D. C. (5 cents.)

Proceedings, Sixteenth Annual Meeting, **American Petroleum Institute**, held at Los Angeles, Calif., Nov. 11-14, 1935. Section III, Refining. American Petroleum Institute, 50 West Fiftieth Street, New York, N. Y.

The Influence of Thin Metal Layers on the **Deterioration of Technical Insulating Oils**, by P. J. Haringhuizen and D. A. Was. Published by International Tin Research and Development Council, 149 Broadway, New York, N. Y. The investigation related to the deterioration of transformer oils and the effects thereon of metals present in thin layers. It was found that copper is most active in increasing sludge formation and acidity, lead less, and tin the least.

List of Publications Relating to **Mines, Explosives, Fuel, Gas, Gasoline and Petroleum** for sale by the Superintendent of Documents, Washington, D. C.—Superintendent of Documents, Washington, D. C.

"Motoring Abroad" is the title of a 240-page book issued by the Foreign Travel Division of the American Automobile Association, giving complete information for tourists intending to travel in Europe by automobile. The book has numerous illustrations, 25 detail maps and a general road map of Europe.

Petroleum Taxation, booklet reprinted from American Petroleum Industry by the American Petroleum Industries Committee, 50 West 50th St., New York, N. Y.

Honorary Degree to Ford For Interest in Farming

An honorary degree of Doctor of Engineering will be conferred upon Henry Ford by the Board of Agriculture at the Michigan State College commencement exercises, June 15.

Mr. Ford has accepted the honor, which is in recognition primarily of his interest in the production on farms of materials which can be used in industry.

Costs Less

Tool department of one of the big companies has developed a revolutionary design of reamer—at least that's the claim made for it. It is rather inexpensive as compared with conventional reamers, can be resharpened many times, and is said to produce more holes between grinds than the most expensive tools the company has used heretofore. It is expected that an announcement of this tool will be made very soon.

Wilkening to Build

The Wilkening Manufacturing Co., makers of Pedrick hydraulic piston rings, has just let a contract for the construction of a building to provide 22,500 sq. ft. of additional manufacturing floor-space at their plant in Southwest Philadelphia. The new facilities will be in full operation by next September.

Calendar of Coming Events

SHOWS

- Yugoslavia 16th International Spring Fair, Lubliana .... May 30-June 11
- France, Automobile Exhibit at Foire de Paris .... May
- Norway, Automobile Show, Oslo ...... May
- Olympia Motor Show, London, England, Oct. 15-24
- National Motor Truck Show (N. J. Motor Truck Assn.), Newark, N. J., Nov. 3-7
- National Automobile Show, Grand Central Palace, New York .... Nov. 11-18
- International Aviation Show, Paris, France .... Nov. 13-29
- Boston Automobile Show .... Nov. 14-21
- Columbus Automobile Show .... Nov. 14-20
- Chicago Automobile Show .... Nov. 14-21
- Detroit Automobile Show .... Nov. 14-21
- Washington, D. C., Automobile Show, Nov. 14-21
- Cincinnati Automobile Show .... Nov. 15-21
- St. Louis Automobile Show ...... Nov. 15-22
- Baltimore Automobile Show .... Nov. 21-28
- Brooklyn Automobile Show ..... Nov. 21-28*
- Cleveland Automobile Show ..... Nov. 21-28
- Kansas City Automobile Show .. Nov. 21-29*
- Milwaukee Automobile Show .... Nov. 22-29
- Peoria Automobile Show ... Nov. 30-Dec. 5*
- Philadelphia Automobile Show, Nov. 30-Dec. 5*
- Natl. Exposition of Power & Mechanical Engineering, Biennial Meeting, New York City .... Nov. 30-Dec. 5
- Automotive Service Industries Joint Show, Chicago .... Dec. 9-14

* Tentative dates.

CONTESTS

- 500-Mile International Sweepstakes, Indianapolis .... May 30

CONVENTIONS AND MEETINGS

- American Iron and Steel Institute, 45th General Meeting, Waldorf-Astoria Hotel, New York .... May 28
- S.A.E. Summer Meeting, White Sulphur Springs, W. Va. .... May 31-June 6
- Automotive Engine Rebuilders Assoc. Annual Convention, Cincinnati, June 1-4
- National Association of Credit Men, 41st Annual Convention, Richmond, Va. June 8-12
- National Oil and Gas Power Conference, American Society of Mechanical Engineers, University of Michigan, Ann Arbor .... June 24-27
- American Society for Testing Materials, Annual Meeting, Atlantic City .... June 29-July 3
- National Association Power Engineers, Annual Meeting, Chicago, Aug. 31-Sept. 4
- American Transit Association, Convention, White Sulphur Springs, W. Va. .... Sept. 21-24
- American Society for Metals, 18th Nat'l Congress, Cleveland, O. .... Oct. 19-23
- American Gas Association, Annual Meeting, Atlantic City .... Oct. 26-31
- American Petroleum Institute, Annual Meeting, Chicago .... Nov. 9-12
- Natl. Industrial Traffic League, Annual Meeting, New York City ..... Nov. 19-20

JUST AMONG OURSELVES

"Eye to the Future" Proves Profitable

IN the May issue of *News and Views*, house organ of the General Motors Acceptance Corp., Fred Horner tells how G. M. has built up its railroad business carefully since 1923 when Alfred P. Sloan, Jr., then a vice-president of the corporation, authorized the formation of a Railroad Service Department.

From this beginning, according to Mr. Horner, "General Motors has not only kept an untiring vigil in the application of automotive products to railroad problems, but has actually produced and sold the bulk of such products that the railroads have used."

Newest and most specific of General Motors contributions to the progress of railroads is the Electro-Motive plant at La Grange, Ill., where Diesel locomotives for switching and main line service are being built according to a production philosophy which reached its finest flowering in the manufacture of motor vehicles. Invested in this plant are $3,500,000, which would seem to justify General Motors' belief, as expressed by Mr. Horner, that the advent of quantity-produced Diesel-electric locomotives heralds the fact that "the time is near for far-reaching changes in this field of railroad operation."

Automotive engineers have contributed much and will continue to contribute much to the progress of railroad transportation. There is no firmer advocate of this belief than Joseph B. Eastman, Federal coordinator of transportation. In his own field he has met with resistance in the application of constructive policies for the development of rail equipment—through research and organized, intelligent economies.

We have a feeling that time will show that the automotive engineers—and Mr. Eastman—were right about what the railroads need.

Hallock's Reply To an Editorial

IN our issue of May 2, in this department, we printed an editorial captioned "Oil for the Waters of Standardization." It was directed, frankly, against an "Open Letter to Automotive Engineers" circulated by the Socony-Vacuum Corp. over the signature of E. F. Hallock, chief engineer, automotive lubricants, and represented our considered judgment on the questions raised by the "Open Letter."

Mr. Hallock has prepared a reply to the editorial, which as a matter of fairness, we are printing below, although it must be noted that we continue to disagree with most of Mr. Hallock's contentions, both as to the principles involved, and his interpretation of the facts as they are evident. —*H. H.*

Mr. Hallock's Letter

"THE S.A.E. Lubricants Committee is deadlocked over the several propositions before it to reclassify automotive oils. A mail vote, following its last session during October, has been rejected by the council as inconclusive; an effort sponsored by committee members representing the petroleum industry to have a meeting called in connection with the Detroit general meeting last January was rejected; nor has any call been issued for a Lubricants Committee meeting, to my knowledge, at White Sulphur this month.

"The entire motive behind my "open letter to Automotive Engineers" referred to in your May 2 editorial, was encompassed in the paragraphs of that letter. It was to break this deadlock, if possible, by shedding light on its causes and offering for consideration and comment a possible new approach to the mutual problem with which both industries are faced.

"My letter made mention of just a couple of our objections to the present S.A.E. Lubricants' grading system; you hit upon another, and infer that it was the real motive which inspired my letter and that we were not frank enough to state it.

"All of our objections to the present grading system, and all of the motives which have actuated us in opposing it, have been frankly stated to the S.A.E. management without reserve, and the file is open for inspection by anyone interested. These objections touch upon the technical soundness, the ethics, the commercial fairness, petroleum representation, the economic soundness, the legality, the degree to which the mutual aspects of this program have been modified, the motives and methods by which modification has been accomplished, and the status of the grading system as an aid to consumer buying. You will also find the file replete with constructive suggestions.

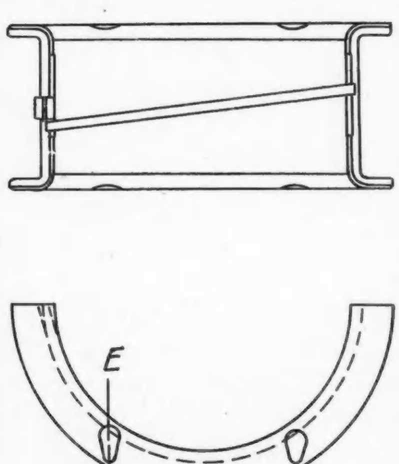
"Your expressed belief that these matters were fully and fairly reviewed by all having an interest in them at the special meeting called by the Council's Committee last year is based on misinformation. Had that been so, our campaign would have terminated then and there—to attain just that is the Socony-Vacuum's major objective in this matter.

"You were mistaken also in stating that automotive engineers were urged in this open letter to abandon use of the present S.A.E. system and recommend in accordance with our suggested method. They were merely asked to review the situation, consider the proposal and comment on it.

(*Turn to page* 746, *please*)

Force-Feed Lubrication Has Led to— New Practice

PRACTICE in oil grooving for automotive engines has changed greatly with the development of lubricating systems generally and with changes in bearing technique. The early engines had splash lubrication and the main bearings were lubricated by pockets cast on top of the bearing bosses which caught the spray; from these pockets the oil gravitated to the bearing surfaces through holes drilled through the bottom. The method of oil supply thus was very similar to that used for the bearings of line shafting, which were lubricated with oil cans, and the type of oil grooving employed also was similar. The most familiar type of grooving consisted of two helical grooves which intersected each other substantially at right angles at the oil hole. The grooves helped to carry the oil toward the ends of the bearings, which was considered desirable because of the relatively large length/diameter ratio of the period and the low pressure head behind the oil; they also tended to carry it around the circumference, but the chief object of the helical form probably was to encourage flow toward the ends of the bearings by sloping the grooves downward.



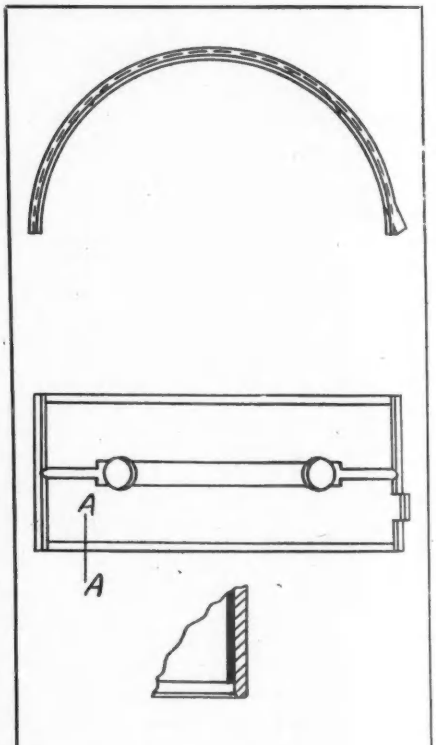
SECTION E-E

Hupp main bearing No. 2, upper half

In modern engine bearings the problem is a rather different one, for the oil is fed to them under considerable pressure. It is carried along by the journal in its rotation, and capillary action together with the pressure behind the feed tends to cause it to flow toward the ends of the bearings. Moreover, the bearings of modern engines are relatively short and the surface velocity is high, for which reason there is little need of oil grooves intended to distribute the oil along the length of the bearing. Grooves are needed mainly because the connecting-rod (and frequently also the piston-pin) bearings are supplied with oil by way of the main bearings.

The oil inlet to the main bearings is located either centrally in the bottom half bushing or somewhat to one side of the center in the top half. In the former case the oil is supplied to the bearings by means of a distributing manifold secured to the bearing caps. This method of distribution, which was very popular some ten years ago, is now gradually disappearing, as many engineers consider it preferable to effect distribution through holes drilled in the engine block, rather than through tubular manifolds. The latter affect reliability of the engine adversely, and, besides, the manifold must be removed and replaced whenever the bearings require servicing. Where the oil enters the bearing near the top, it is forced through an inclined drill hole intersecting the longitudinal main header, which latter, like the inclined oil passage, is drilled in the engine block.

From the main bearing the oil passes



SECTION A-A

Reo intermediate main bearing, upper half

to the connecting-rod bearing through a drill hole in the crankshaft. As a rule, the main-bearing end of this hole is so located that it will register with the oil inlet to the main bearing once per revolution, but if this short registering period were depended upon to supply oil to the connecting-rod bearing, the latter would receive a less copious supply than the main bearing,

By P. M. Heldt

in Oil-Grooving

Oil grooves in engine bearings today are used more to permit of continuous or nearly continuous feed to crank-pin and piston-pin bearings than to distribute the oil over the whole bearing surface. Rear main bearings sometimes have circumferential grooves cut near their rear ends to collect the oil working through the bearing and return it to the crankcase.

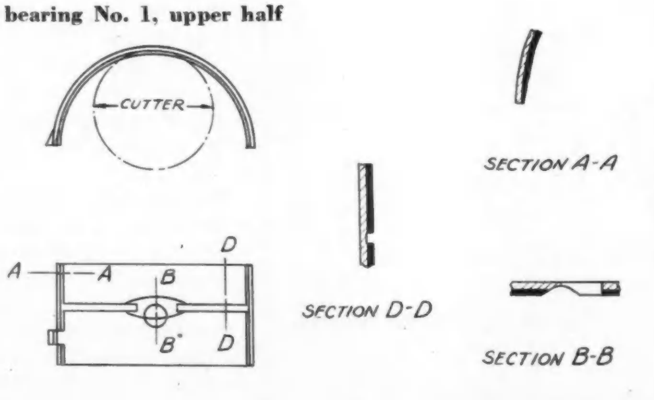
although it is usually more heavily loaded. To avoid this, a circular groove through the oil inlet hole is cut in the main bearing, so that the oil hole in the crankshaft is in full communication with the oil inlet to the main bearing during the whole, or at least the greater part, of the crankshaft revolution.

It is in the form of these circumferential oil grooves that we encounter the first difference in modern bearing practices. In some engines the groove extends completely around the bearing, parallel with the ends thereof, so that the connecting-rod bearing is in continuous communication with the main oil header. So far as lubrication of the connecting-rod bearing is concerned, this is evidently the best arrangement. An additional advantage claimed for the continuous circumferential groove is that it obviates so-called hydraulic knock. It is easily understood that if the flow of oil to the connecting-rod bearings is shut off periodically, the column of liquid in motion is suddenly brought to a stop, or at least materially retarded, with resulting "oil knock." Where the oil groove does not extend all around the bearing it is usually made to run out gradually, undoubtedly with the idea of minimizing the rate of retardation of oil flow.

It is sometimes objected to a continous oil groove parallel with the ends of the bearing that it tends to wear a ridge on the journal. If the oil groove extends only partly around the bearing there is, of course, no danger of wearing such a ridge. Another precaution against this eventuality is to turn the groove in a plane which is not perpendicular to the axis of the bearing. Formation of a ridge would be prevented if the groove were sufficiently inclined so as to be entirely to one side of the oil inlet to the crankshaft in one angular position and entirely to the opposite side of the inlet a half revolution further. In some designs the groove is made parallel with the ends in one half of the bearing (the one through which the oil enters) and inclined or helical in the other half.

In a good many engines the camshaft bearings also are pressure-oiled, and if the main oil header is located on the opposite side of the crankcase from the camshaft, then the oil is delivered to the camshaft bearings by way of the main bearings. In one engine the oil from the main header enters the main bearing 33 deg. from the top and leaves it for the camshaft bearing 33

Chrysler main bearing No. 1, upper half



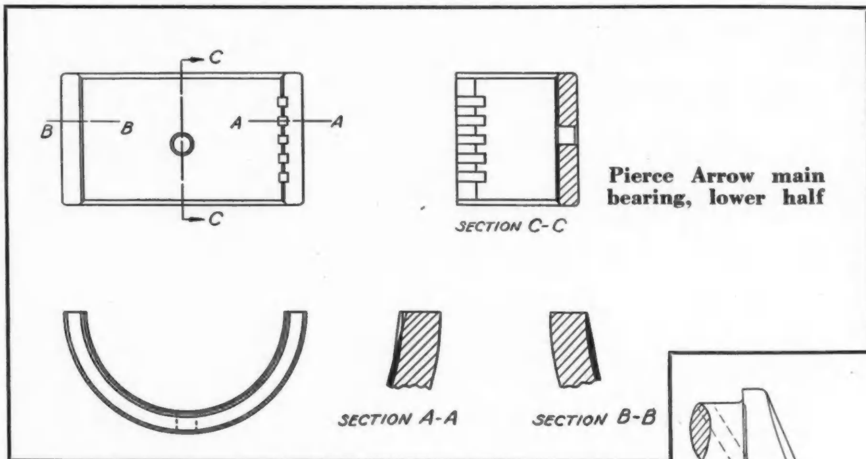
deg. from the top in the opposite direction. The inlet and outlet holes in the main bearing are connected by a straight circumferential groove 3/16 in. wide; the groove actually extends completely around the bearing, but over the remaining portion of the circumference it is only 1/16 in. wide. Having both oil ducts at the same angle with the parting plane is evidently a convenience in production.

In the Willys 77 there are two inlets to the oil passage through the crankshaft from each of the three main bearings, one drill hole extending through the main bearing, crank arm and crankpin in the usual way, and a second hole being drilled in the main bearing at a point exactly opposite the beginning of the former, and at the same inclination, so it meets it at the crankshaft axis. In this engine there is a circumferential groove only in the upper main-bearing shell, which extends over about 90 deg. of arc, but on account of the double inlet, the crankpin bearing is in communication with the source of oil supply about 50 per cent of the time.

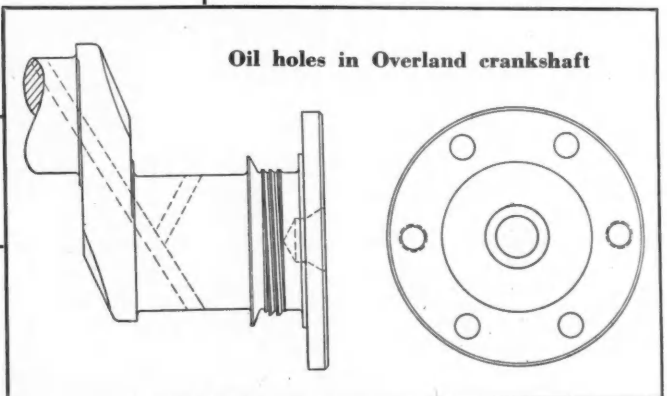
In addition to the circumferential oil groove, a good many engines have a certain amount of relief at the junction between the halves of the bearing. In some bearings other than those of internal combustion engines, in which the load is always in a substantially downward direction, a comparatively wide relieved zone is provided at the parting lines, because it tends to reduce the bearing friction. As the load is never even nearly horizontal, this portion of bearing surface never carries any load; without relief, the shearing of the comparatively thin oil film results in friction losses, and by providing relief, this loss is prevented. In the main bearings of internal combustion engines the load travels completely around the circle, although it is usually somewhat smaller when near the horizontal than when near the vertical direction; it would therefore be inadvisable to provide a wide relief, as this would materially reduce the effective bearing area when the load is horizontal or nearly so.

Most of the thin wall bearings now so widely used in automobile engines are given a small amount of relief along the parting lines, the depth of the relief usually amounting to from 0.0005 to 0.001 in. and the width back from the parting line to ¼ to ½ in., the relief fading away with increase in the distance from the parting line.

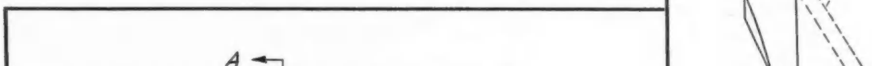
In some bearigs, however, considerably more relief is provided, but in that case it does not extend over the whole length of the bearing, for it can easily be seen that if it did, it would be impossible to maintain any pressure on the crankpin bearings, as the oil entering the main bearing could escape through the circumferential groove and the relief. The length of the relieved portion ranges from one-third the length of the bearing to nearly the full length—in some cases the unrelieved portion at each end is only 1/16 in. wide. Where such relief as here described is provided, the object seems to be a double one—to spread the oil along



Pierce Arrow main bearing, lower half



Oil holes in Overland crankshaft

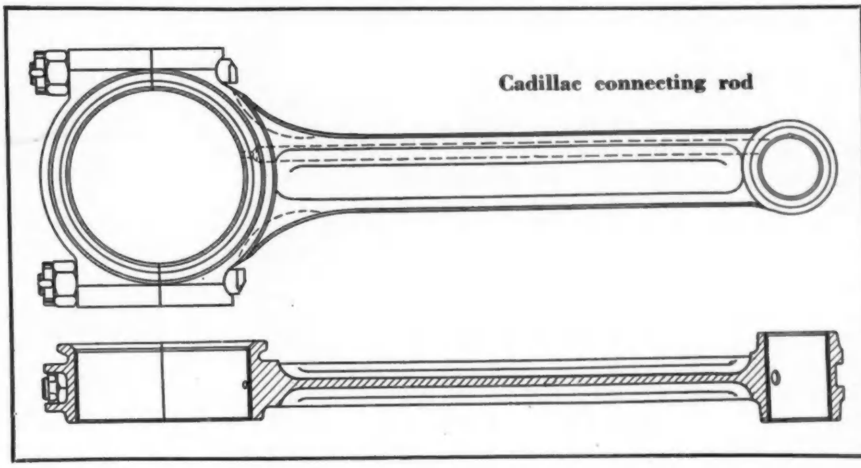


Oldsmobile main bearing No. 4, lower half

the length of the bearing and to provide pockets in which any solid material getting into the bearing can collect. In some designs the relief at the parting lines is divided into a number of comparatively narrow sections, separated by sections of about equal width without relief.

In some engines the rear main bearing has an extra oil groove near its rear end. This, however, is not an oil-distributing but an oil-collecting groove, there being a drill hole through the shell at the lowest part of the bearing, from which any oil collected in the groove drains off and returns to the crankcase.

Quite a number of engines now have oil holes in the connecting-rod heads, through which oil is sprayed into the cylinders when the crank is near the top dead center. Where such connecting-rod oil holes are provided, it is neessary, of course, that when these register with the oil hole in the crankshaft, there should be a continuous open passage from the main oil distributor head to the oil hole in the crankshaft. This hole is usually located some 30 deg. forward of the top center of the connecting rod bearing, and the oil groove in the main bearing must therefore extend around the bearing far enough so that it still registers with the oil hole in the crankshaft when the main-bearing end of that hole is 30 deg. beyond the bottom position.

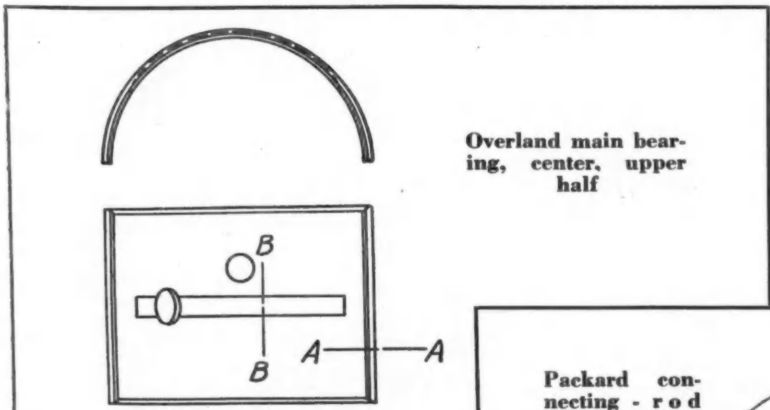


Cadillac connecting rod

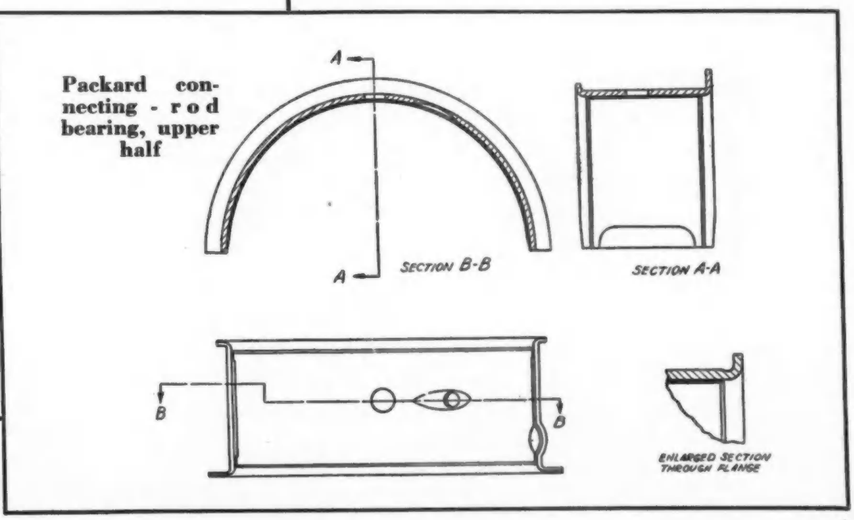
End thrust on the crankshaft is usually taken up on one of the main bearings, which is provided with wide flanges on its half bushings or bearing shells. In order that lubricant may be supplied in adequate quantity to these thrust surfaces, the lower shell is provided with oil pockets or grooves that catch some of the oil working through the main bearings and distribute it over the whole width of the thrust surface. A typical arrangement is shown by one of the drawings reproduced herewith, which represents main bearing No. 3 of the Hupp engine. In the Buick the oil is distributed over the thrust surface by a circular groove eccentric with the bearing, starting at the inner diameter of the flange and fading out 3/16 in. from the outer edge about a quarter of the way around the circle.

The earlier bearing bushings were usually held in position by means of dowel pins or dowel screws. With the thin-walled bearings this construction is no longer possible, or at least inconvenient. In these thin-walled bushings a sort of tongue is punched from the shell at one parting line, about ¼ in. wide and bent outward from the shell to form a spur. The end of this spur is supported by the parting surface of the main bearing (block or cap), the spur being forced against it by the frictional force between journal and bearing. This device locates the bearing not only angularly but also endwise.

Main bearings from which there is no oil feed to either the connecting-rod bearing or the camshaft bearings sometimes have no oil grooves at all. This applies, for instance, to five main bearings of the Studebaker eight-cylinder engines in which the connecting-rod bearings are supplied through oil holes from four of the main bearings.



Overland main bearing, center, upper half

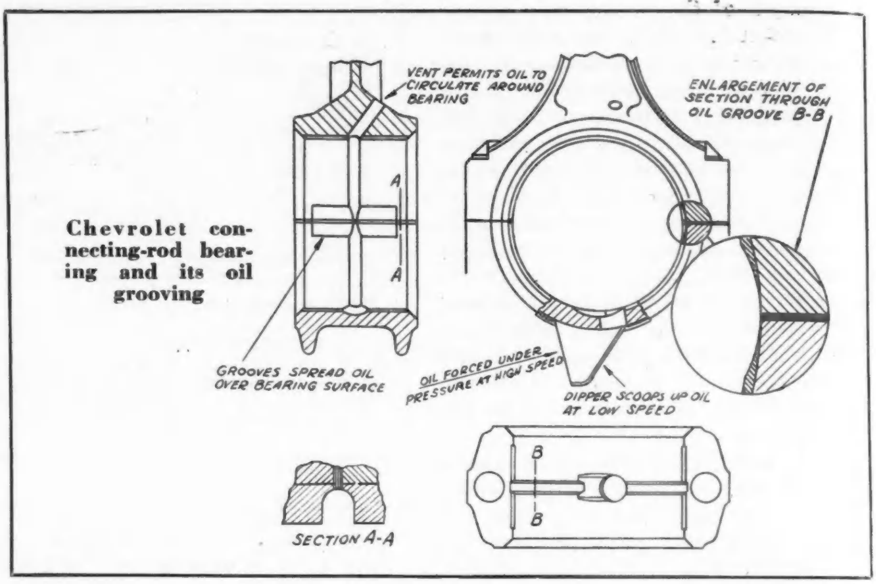


Packard connecting-rod bearing, upper half

One advantage of oil grooves in conjunction with relief is that they afford an opportunity for solid particles finding their way into the lubricating system to pass through the main bearings without getting onto the bearing surfaces and therefore without scratching or scoring these surfaces.

Connecting-Rod Bearings

Connecting rod bearings, as a rule, have no grooving at all, but in some cases where there is an oil hole drilled in the head from which a spray is thrown into the cylinders, a groove is formed in the bearing so that the spray hole will remain in communication with the crankshaft oil hole longer, the groove being made from ½ to ¾ in. long. The majority of engines provided with this spray hole have no grooving through the hole. When a groove is used it is generally made to fade out at the ends. The thin-walled half bushings used for the connecting-rod bearings have the same anchoring spur as the main bearings, usually between ⅛ and 3/16 in. wide and projecting about 1/32 in. beyond the outer contour of the bearing.

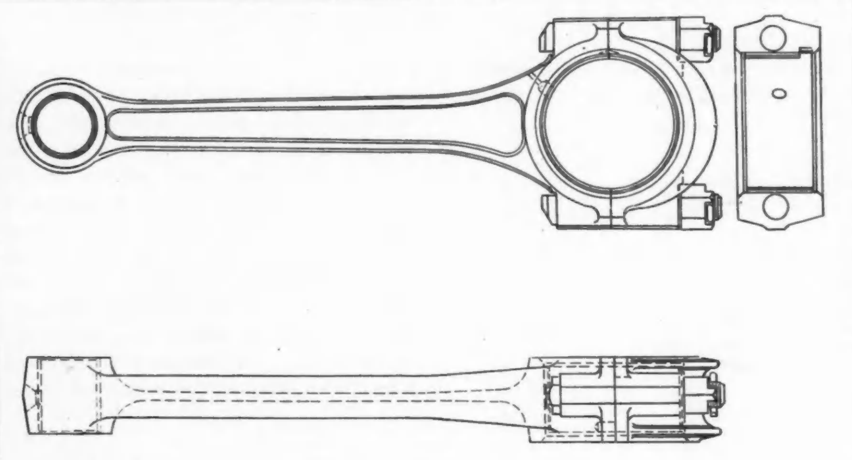


Chevrolet connecting-rod bearing and its oil grooving

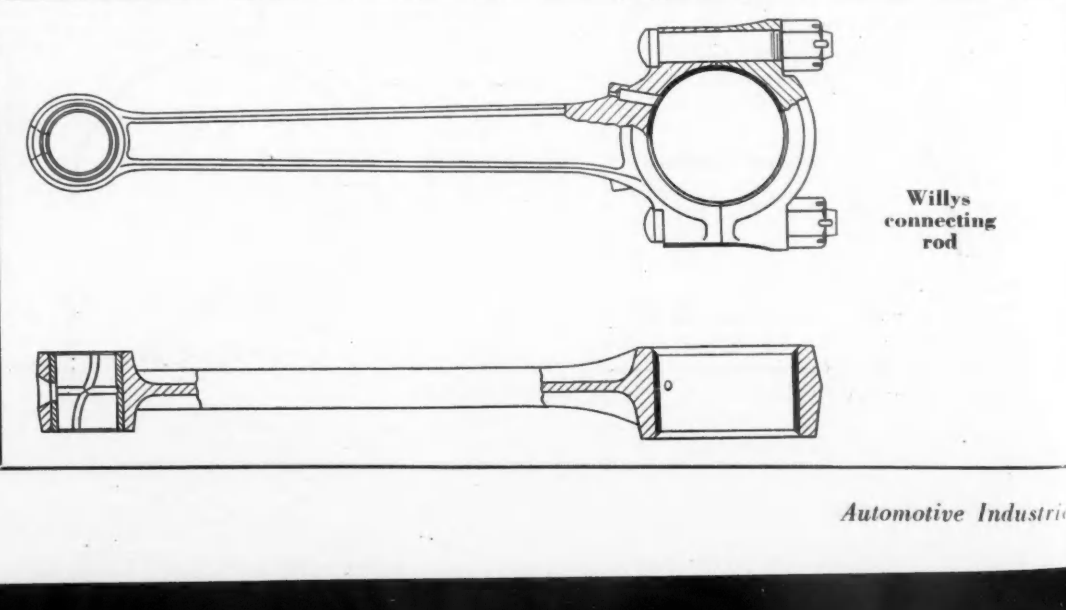
Connecting-rod bearings, the same as main bearings, are given a small amount of relief along their parting lines. It has been found that if the bushings are machined exactly to size, placed in the big ends, and the nuts on the cap bolts are then screwed up tight, the bushings will contract at the parting lines and "nib" the crankpin. This is evidently due to a slight compression of the metal of the connecting-rod head under the compressive force exerted by the bolts, which causes the portions of the half bushings along the parting lines to deflect inward and fill up the clearance space. By cutting a relief of from 0.0005 to 0.001 in. along the parting lines, the whole length of the bearing, nibbing can be prevented. An alternate method consists in inserting shims about 0.0015 in. thick between rod and cap when boring the big end of the rod and making the bore sufficiently large so that the bearing will not bind on the crankpin when these shims are removed and the cap bolts are tightened. An advantage of this method of finishing connecting-rod bearings is that the extra clearance is taken up by the compressive forces due to tightening the cap bolts and all of the bearing surface therefore is effective.

The spray hole in the connecting-rod head is usually of only about 1/16 in. diameter at the outer end, while the

(Turn to page 740, please)



Chrysler connecting rod



Willys connecting rod

Eleven Car Makers Double Earnings

DURING 1935, 11 of the leading manufacturers of motor vehicles increased their net income from the 1934 consolidated total of $85,690,000 to $197,771,000. The same companies in 1935 paid $117,560,000 in dividends on their common and preferred stocks, against $81,912,000 paid in the previous year.

These are the final gages of an immense improvement in automotive business which brought for the companies included in the tabulations on the two succeeding pages improvement in cash position, current assets, working capital, surplus, and a substantial reduction in the amount of funded debt reported.

The value of inventories at the end of 1935 had risen to $287,169,000 compared with $213,329 at the end of 1934. The depreciated value of plants and property remained about the same at the end of 1935 as it was in 1934, while capital and surplus were valued at $1,254,874,000 in 1935, a substantial increase over the 1934 figure of $1,174,285,000.

None of the above figures include the Hupp Motor Car Corp., whose report on 1935 operations has been held up pending court decisions establishing the legal status of the corporation.

In the financial tabulations which appear on the next two pages, Hupp's position for the years 1929 to 1934 has been included to give a better view of the true magnitude of the industry during those years. The 1935 figures have been arranged in such a way that they may be included when the report is published. No figures covering the Ford Motor Co. have been included.

In a later issue, when the modified balance sheet of the Ford Motor Co. for 1935 has been filed in the states which require it for the conduct of business in the state, we plan to publish a consolidated balance sheet for 1935 of the entire automobile manufacturing industry.

Our June 20 issue will contain an analysis similar to that included on the next two pages, covering the leading companies in the parts and accessory manufacturing industry.

U. S. Registration of New Vehicles

	1929	1931	1932	1933	1934	1935
General Motors..	1,491,000	937,000	522,000	753,000	920,480	1,219,542
Chrysler Corp....	388,900	243,530	199,850	413,700	480,570	691,391
Total.........	1,879,000	1,180,530	721,850	1,166,700	1,401,050	1,910,933
Auburn.........	19,300	31,130	11,980	5,040	5,540	5,163
Graham.........	62,600	19,320	12,855	10,130	12,890	15,965
Hudson.........	262,900	62,100	37,420	38,780	60,335	76,063
Hupp..........	45,900	17,530	10,790	6,730	6,570	7,450
Mack..........	6,800	3,000	1,425	1,650	1,830	1,515
Nash..........	108,800	39,600	20,230	11,350	24,620	35,184
Packard........	46,200	16,350	11,055	9,080	6,550	37,653
Reo...........	30,900	12,000	7,060	6,670	8,890	8,995
White..........	6,100	2,600	2,140	1,380	3,960	3,304
Total.........	589,500	203,630	114,955	90,810	131,185	191,292
Grand Total.....	2,469,400	1,384,160	836,805	1,527,510	1,532,235	2,102,225
Total less Hupp	2,423,500	1,366,630	826,015	1,520,780	1,525,665	2,094,775

Sales Volume*

	1929	1931	1932	1933	1934	1935
General Motors..	$1,504,404	$808,841	$432,312	$569,011	$862,673	$1,155,642
Chrysler Corp....	375,033	183,805	136,547	238,676	362,255	516,830
Total.........	$1,879,437	$992,646	$568,859	$807,687	$1,224,928	$1,672,472
Auburn.........	37,551	37,086	12,845	5,360	10,406	9,308
Graham.........	64,490	16,499	10,491	8,333	11,595	14,622
Hudson.........	201,018	38,236	25,862	23,521	52,568	63,077
Hupp..........	52,506	15,260	8,751	6,119	7,196	....
Mack..........	57,227	27,621	13,218	15,744	18,346	20,211
Nash..........	108,860	35,928	15,331	8,984	19,671	27,812
Packard........	†107,542	29,987	15,516	19,230	14,619	49,966
Reo...........	48,011	17,044	9,096	10,260	13,836	16,136
White..........	48,653	23,517	17,117	13,615	20,540	19,908
Total.........	$725,858	$241,178	$128,227	$111,166	$168,777	$221,040
Grand Total.....	$2,605,295	$1,233,824	$697,086	$918,853	$1,393,705	....
Total less Hupp	$2,552,789	$1,218,564	$688,335	$912,734	$1,386,509	$1,893,512

Net Income‡ *

	1929	1931	1932	1933	1934	1935
General Motors..	$245,976	$96,877	$165	$83,214	$94,769	$167,431
Chrysler Corp....	21,902	1,469	**d11,254**	12,129	9,535	34,976
Total.........	$267,872	$98,346	**d$11,089**	$95,343	$104,304	$202,470
Auburn.........	3,603	3,580	**d975**	**d2,308**	**d3,642**	**d2,698**
Graham.........	**d1,464**	**d4,736**	**d2,811**	67	**d475**	**d1,701**
Hudson.........	11,595	**d1,991**	**d5,429**	**d4,410**	**d3,239**	585
Hupp..........	3,469	**d4,249**	**d4,515**	**d1,778**	**d4,398**	....
Mack..........	6,841	**d3,032**	**d1,480**	**d948**	17	**d396**
Nash..........	18,014	4,808	1,030	**d1,189**	**d1,625**	**d610**
Packard........	25,183	**d2,909**	**d6,824**	107	**d7,291**	3,316
Reo...........	1,074	**d2,749**	**d2,879**	**d2,588**	**d958**	**d220**
White..........	2,548	**d3,235**	**d3,619**	**d3,169**	**d1,401**	**d2,912**
Total.........	$70,863	**d$14,513**	**d$27,502**	**d$16,216**	**d$23,012**	**d$4,636**
Grand Total.....	$338,735	$83,833	**d$38,591**	$79,127	$81,292	....
Total less Hupp	$335,266	$88,082	**d$34,076**	$80,905	$85,690	$197,771

Common and Preferred Dividends*

	1929	1931	1932	1933	1934	1935
General Motors..	$165,954	$139,876	$63,199	$63,005	$73,622	$105,649
Chrysler Corp....	13,336	4,412	4,390	4,304	5,432	8,665
Total.........	$179,290	$144,288	$67,589	$67,309	$79,054	$114,314
Auburn.........	645	824	835	553	223	....
Graham.........	372	329	30	....	....	....
Hudson.........	8,180	1,597	....	....	....	....
Hupp..........	2,760	....	....	....	....	....
Mack..........	4,534	1,680	692	665	650	$600
Nash..........	16,380	9,555	4,095	1,985	1,985	2,646
Packard........	17,234	6,746	....	....	....	....
Reo...........	2,400	772	....	....	....	....
White..........	1,000	355	3,125	....	....	....
Total.........	$53,505	$21,858	$8,777	$3,203	$2,858	$3,246
Grand Total.....	$232,795	$166,146	$76,366	$70,512	$81,912	$117,560
Total less Hupp	$230,035	$166,146	$76,366	$70,512	$81,912	$117,560

Cash and Securities*

	1929	1931	1932	1933	1934	1935
General Motors..	$127,352	$205,029	$172,781	$177,304	$186,967	$199,435
Chrysler Corp....	38,706	50,233	42,603	37,370	32,416	59,118
Total.........	$166,058	$255,262	$215,384	$214,674	$219,383	$258,553
Auburn.........	2,082	8,410	5,138	3,983	1,115	511
Graham.........	6,180	1,482	528	707	523	306
Hudson.........	17,145	8,909	4,199	2,680	2,576	9,584
Hupp..........	10,156	7,096	4,904	3,585	1,035	....
Mack..........	1,899	7,041	9,768	7,766	5,062	3,256
Nash..........	42,011	36,550	32,135	29,915	27,257	24,521
Packard........	17,910	13,995	13,387	15,161	12,396	12,486
Reo...........	9,563	6,159	5,972	1,480	2,427	1,408
White..........	10,657	8,630	7,762	5,836	2,508	1,757
Total.........	$117,603	$98,272	$83,793	$71,113	$54,899	$53,829
Grand Total.....	$283,661	$353,534	$299,177	$285,787	$274,282	....
Total less Hupp	$273,505	$346,438	$294,273	$282,202	$273,247	$312,382

Inventories*

	1929	1931	1932	1933	1934	1935
General Motors..	$188,473	$106,471	$75,479	$115,585	$138,598	$196,325
Chrysler Corp....	38,102	22,104	18,377	34,557	37,534	48,766
Total.........	$226,575	$128,575	$93,856	$150,142	$176,132	$245,091
Auburn.........	8,754	4,454	4,011	2,780	3,194	2,780
Graham.........	7,343	2,555	1,410	1,052	1,289	1,718
Hudson.........	13,467	4,476	3,615	4,492	4,562	4,885
Hupp..........	8,481	4,271	2,115	1,736	1,495	....
Mack..........	20,306	10,369	9,047	8,694	8,484	8,400
Nash..........	5,246	1,348	1,023	2,077	2,138	2,733
Packard........	13,624	7,874	5,763	5,451	4,777	8,109
Reo...........	10,051	5,200	3,454	3,310	3,905	4,364
White..........	15,566	9,219	8,397	7,981	8,848	9,089
Total.........	$102,838	$49,766	$38,835	$37,573	$38,692	$42,078
Grand Total.....	$329,413	$178,341	$132,691	$187,715	$214,824	....
Total less Hupp	$320,932	$174,070	$130,576	$185,979	$213,329	$287,169

Current Assets*

	1929	1931	1932	1933	1934	1935
General Motors..	$368,961	$358,503	$279,978	$317,515	$365,844	$465,028
Chrysler Corp....	90,313	76,320	65,682	74,640	87,089	128,204
Total.........	$459,274	$434,823	$345,660	$392,155	$452,933	$593,232
Auburn.........	13,327	14,401	10,898	8,549	5,681	3,866
Graham.........	14,554	4,647	2,163	1,891	1,960	2,486
Hudson.........	34,474	14,749	8,666	7,533	7,883	16,279
Hupp..........	19,882	11,926	7,283	5,661	2,874	....
Mack..........	44,293	32,225	29,205	26,695	23,378	22,597
Nash..........	53,141	39,787	34,145	33,191	30,156	28,626
Packard........	38,080	24,519	20,450	22,252	18,656	24,851
Reo...........	22,688	12,434	9,984	7,887	7,147	8,523
White..........	32,197	23,460	19,411	16,784	15,096	13,772
Total.........	$272,636	$178,148	$142,205	$130,433	$112,831	$121,000
Grand Total.....	$731,910	$612,971	$487,865	$522,588	$565,764	....
Total less Hupp	$712,028	$601,045	$480,582	$516,927	$562,890	$714,232

Current Liabilities*

	1929	1931	1932	1933	1934	1935
General Motors..	$117,673	$84,587	$57,822	$76,183	$90,199	$145,066
Chrysler Corp....	18,928	11,328	16,395	21,223	37,686	66,901
Total.........	$136,601	$95,915	$74,217	$97,406	$127,885	$211,967
Auburn.........	3,296	1,924	330	618	649	1,941
Graham.........	2,984	2,619	1,297	995	1,463	2,383
Hudson.........	8,271	3,590	2,200	4,461	3,138	6,704
Hupp..........	2,541	1,715	1,074	1,107	676	....
Mack..........	7,209	1,632	1,667	1,905	1,784	2,436
Nash..........	8,860	2,710	1,145	2,312	1,407	2,537
Packard........	13,204	3,123	2,325	2,330	4,695	6,554
Reo...........	2,717	1,398	849	955	1,106	2,039
White..........	3,176	1,353	1,096	1,598	1,369	2,140
Total.........	$52,258	$20,064	$11,983	$16,281	$19,287	$26,734
Grand Total.....	$188,859	$115,979	$86,200	$113,687	$147,172	....
Total less Hupp	$186,318	$114,264	$85,126	$112,580	$146,496	$238,701

* 000 omitted **d** deficit † Year ending Aug. 31, 1929 ‡ After interest, taxes and depreciation

Working Capital*

	1929	1931	1932	1933	1934	1935
General Motors	$251,288	$273,916	$222,156	$241,332	$275,646	$319,961
Chrysler Corp.	71,385	64,992	49,286	53,417	49,402	61,303
Total	$322,673	$338,908	$271,442	$294,749	$325,048	$381,264
Auburn	10,031	12,477	10,568	7,930	5,032	1,925
Graham	11,570	2,028	866	896	498	103
Hudson	26,203	11,159	6,466	3,072	1,745	9,575
Hupp	17,342	10,211	6,209	4,554	2,198	....
Mack	37,084	30,593	27,538	24,790	21,594	20,161
Nash	44,281	37,077	33,000	30,879	28,748	26,089
Packard	24,876	21,396	18,125	19,922	13,961	18,297
Reo	19,972	11,036	9,135	6,932	6,042	6,485
White	29,021	22,107	18,315	15,186	13,727	11,632
Total	$220,380	$158,084	$130,222	$114,161	$93,545	$94,267
Grand Total	$543,053	$496,992	$401,664	$408,910	$418,593	....
Total less Hupp	$525,711	$486,481	$395,455	$404,356	$416,395	$475,531

Plant and Property—Depreciated*

	1929	1931	1932	1933	1934	1935
General Motors	$415,785	$362,628	$328,274	$303,765	$305,678	$319,178
Chrysler Corp.	83,624	65,513	61,697	60,409	59,356	53,577
Total	$499,409	$428,141	$389,971	$364,174	$365,034	$372,755
Auburn	7,075	7,834	7,343	6,732	6,216	5,454
Graham	13,987	11,843	6,640	6,340	5,020	4,638
Hudson	33,276	29,338	25,614	24,440	22,567	20,972
Hupp	16,407	11,315	8,463	7,843	5,928	....
Mack	20,506	17,184	16,643	16,091	16,045	15,812
Nash	9,161	6,819	6,029	5,413	4,376	3,812
Packard	37,870	33,442	31,319	29,117	27,842	27,008
Reo	10,689	9,663	4,646	3,899	3,893	3,636
White	9,634	8,545	7,942	7,407	10,092	8,856
Total	$158,605	$135,983	$114,639	$108,282	$101,979	$90,188
Grand Total	$658,014	$564,124	$504,610	$472,456	$467,013	....
Total less Hupp	$641,607	$552,809	$496,147	$464,613	$461,085	$462,943

Capital Stock*

	1929	1931	1932	1933	1934	1935
General Motors	$571,924	$622,537	$622,537	$622,537	$622,537	$622,537
Chrysler Corp.	73,756	73,122	21,847	21,807	21,729	21,662
Total	$645,680	$695,659	$644,384	$644,344	$644,266	$644,199
Auburn	7,993	9,849	10,714	10,946	10,946	10,946
Graham	14,004	13,690	3,788	3,783	3,036	2,921
Hudson	19,958	19,958	19,958	19,958	19,958	19,958
Hupp	14,754	13,319	13,291	13,291	13,291	....
Mack	3,900	3,940	3,381	3,337	3,137	2,987
Nash	13,887	13,887	13,887	13,887	13,887	13,887
Packard	50,000	50,000	40,000	40,000	40,000	30,000
Reo	20,000	18,105	9,000	9,000	9,000	9,000
White	40,000	32,500	31,250	31,250	31,250	31,250
Total	$184,496	$175,248	$145,269	$145,452	$144,505	$120,949
Grand Total	$830,176	$870,907	$789,653	$789,796	$788,771	....
Total less Hupp	$815,422	$857,588	$776,362	$776,505	$775,480	$765,148

Surplus*

	1929	1931	1932	1933	1934	1935
General Motors	$380,560	$301,266	$238,232	$248,961	$270,109	$331,680
Chrysler Corp.	54,087	39,679	52,695	60,043	64,094	90,331
Total	$434,647	$340,945	$290,927	$309,004	$334,203	$422,011
Auburn	6,210	7,596	4,859	1,732	d1,930	d4,757
Graham	8,570	d1,823	2,071	2,199	2,553	2,618
Hudson	38,726	20,146	11,686	7,276	4,036	5,104
Hupp	18,942	9,443	2,013	236	d2,407	....
Mack	54,761	47,397	41,490	39,744	38,387	36,807
Nash	39,771	29,123	26,301	23,793	20,466	17,695
Packard	15,584	5,223	8,398	8,905	1,614	14,930
Reo	10,834	3,874	5,284	2,718	1,740	1,494
White	8,678	7,979	2,088	d1,081	d2,264	d6,176
Total	$202,076	$128,958	$104,190	$85,528	$62,195	$67,715
Grand Total	$636,723	$469,903	$395,117	$394,532	$396,398	....
Total less Hupp	$617,781	$460,460	$393,104	$394,296	$398,805	$489,726

Capital and Surplus*

	1929	1931	1932	1933	1934	1935
General Motors	$952,484	$923,803	$860,769	$871,498	$892,646	$954,217
Chrysler Corp.	127,843	112,801	74,542	81,850	85,823	111,993
Total	$1,080,327	$1,036,604	$935,311	$953,348	$978,469	$1,066,210
Auburn	14,203	17,445	15,573	12,684	9,016	6,189
Graham	22,574	11,867	5,859	5,982	5,589	5,539
Hudson	58,684	40,104	31,644	27,234	23,994	25,062
Hupp	33,696	22,762	15,304	13,527	10,884	....
Mack	58,661	51,337	44,871	43,081	41,524	39,794
Nash	53,658	43,010	40,188	37,680	34,353	31,582
Packard	65,584	55,223	48,398	48,905	41,614	44,930
Reo	30,834	21,979	14,284	11,718	10,740	10,494
White	48,678	40,479	33,338	30,169	28,986	25,074
Total	$386,572	$304,206	$249,459	$230,980	$206,700	$188,664
Grand Total	$1,466,899	$1,340,810	$1,184,770	$1,184,328	$1,185,169	....
Total less Hupp	$1,433,203	$1,318,048	$1,169,466	$1,170,801	$1,174,285	$1,254,874

Goodwill, Patents, Etc.*

	1929	1931	1932	1933	1934	1935
General Motors	$50,680	$51,939	$51,839	$51,838	$51,838	$50,326
Chrysler Corp.	25,000	25,000	....	....	....	....
Total	$75,680	$76,939	$51,839	$51,838	$51,838	$50,326
Auburn	....	....	....	....	....	....
Graham	....	....	....	....	....	....
Hudson	....	....	....	....	....	....
Hupp	....	....	....	....	....	....
Mack	2,438	2,438	2,438	2,438	2,438	2,438
Nash	....	....	....	....	....	....
Packard	....	....	....	....	....	....
Reo	....	....	....	....	....	....
White	5,389	5,389	5,389	5,389	5,389	5,389
Total	$7,827	$7,827	$7,827	$7,827	$7,827	$7,827
Grand Total	$83,507	$84,766	$59,666	$59,665	$59,665	....
Total less Hupp	$83,507	$84,766	$59,666	$59,665	$59,665	$58,153

Capital and Surplus Less Goodwill, Etc.*

	1929	1931	1932	1933	1934	1935
General Motors	$901,804	$871,864	$808,930	$819,660	$840,808	$923,881
Chrysler Corp.	102,843	87,801	74,542	81,850	85,823	111,993
Total	$1,004,647	$959,665	$883,472	$901,510	$926,631	$1,035,874
Auburn	14,203	17,445	15,573	12,684	9,016	6,189
Graham	22,574	11,867	5,859	5,982	5,589	5,539
Hudson	58,684	40,104	31,644	27,234	23,994	25,062
Hupp	33,696	22,762	15,304	13,527	10,884	....
Mack	56,223	48,899	42,433	40,643	39,086	37,356
Nash	53,658	43,010	40,188	37,680	34,353	31,582
Packard	65,584	55,223	48,398	48,905	41,614	44,930
Reo	30,834	21,979	14,284	11,718	10,740	10,494
White	43,289	35,090	27,949	24,780	23,597	19,685
Total	$378,745	$296,379	$241,632	$223,153	$198,873	$180,837
Grand Total	$1,383,392	$1,256,044	$1,125,104	$1,124,663	$1,125,504	....
Total less Hupp	$1,349,696	$1,233,282	$1,109,800	$1,111,136	$1,114,620	$1,216,711

Funded Debt, Bonds, Debentures, Etc.*

	1929	1931	1932	1933	1934	1935
General Motors	$1,992	....	....	....	....	....
Chrysler Corp.	49,765	$44,411	$42,331	$40,027	$30,150	....
Total	$51,757	$44,411	$42,331	$40,027	$30,150	....
Auburn	512	359	131	98	....	....
Graham	3,125	2,325	1,805	1,567	1,336	1,686
Hudson	....	....	....	....	....	5,750
Hupp	....	....	....	....	....	....
Mack	2,200	1,800	541	....	....	....
Nash	....	....	....	....	....	....
Packard	....	....	....	....	....	....
Reo	....	....	....	....	....	....
White	42	....	....	....	949	773
Total	$5,879	$4,484	$2,477	$1,665	$2,285	$8,209
Grand Total	$57,636	$48,895	$44,808	$41,692	$32,435	....
Total less Hupp	$57,636	$48,895	$44,808	$41,692	$32,435	$8,209

* 000 omitted   d deficit

Use of Alloy Cast

Table 1. Automobile Cylinder Blocks and Crankcases

Analysis	1	2	3	4
Silicon	2.00-2.20%	2.00-2.35%	1.80-2.00%	2.15-2.25%
Total Carbon	3.25-3.40	3.00-3.40	3.20-3.40	3.10-3.40
Graphite	2.60-2.75	......	2.60-2.80	2.75-2.95
Combined Carbon	0.55-0.75	0.65 Min.	0.60-0.80	0.30-0.50
Sulfur	0.09-0.12	0.14 Max.	0.12-0.15	0.10-0.14
Phosphorus	0.14-0.18	0.10-0.30	0.16-0.20	0.12-0.18
Manganese	0.70-0.85	0.70-0.95	0.70-0.90	0.50-0.70
Nickel	0.75-0.85	0.40 Min.	......	0.20-0.40
Chromium	0.25-0.35	0.20-0.30	0.15-0.20	0.20-0.40
Molybdenum	......	......	0.15-0.20	......
Brinell	187-196	240 Max.	212-231	187-228
Transverse Bar Diam. and Centers—In.	1.20 x 12	0.875 x 12	1.25 x 12	1.20 x 18
Transverse Load—Lb.	3600-3900	1900-2400	4600-5000	2300-2500
Transverse Defl.—In.	0.12-0.14	......	0.14-0.16	0.20-0.28
Tensile PSI x 10^3	33-36	......	38-41	32-37

THE use of alloy iron castings has spread rapidly during the past few years in every field in which non-alloyed iron castings are used. In addition, new uses have been developed for alloy irons, some of them at the expense of other metals.

The automotive industries probably rank first among the users of alloy iron castings. There are a number of reasons why the use of alloy iron has spread in the automotive industries in particular. Modern automobile, truck, bus and tractor engines are, in general, relatively high-compression, high-speed units requiring dense, close-grained, wear- and heat-resisting castings with a certain degree of corrosion resistance. In addition, relatively high strength, rigidity and vibration-damping capacity are needed in the castings used. Marine engines also require wear, heat, and corrosion-resisting irons with high vibration-damping capacity, and are utilizing alloy irons. In general the various physical properties of unalloyed irons, in which the automotive engineer is interested, can be improved by the use of various alloys and combinations of alloys. Alloyed irons are in general much better suited to heat treatment than unalloyed irons, and are thus more useful to the automotive industries.

From the casting producer's viewpoint there are further reasons for employing alloys in certain of the castings which he produces, particularly in cupola-melted irons. Usually it is not practical for a foundry to have a variety of irons coming from the cupola at different times of the day for the various types of castings that are produced. Some castings require high hardness and strength, others heat resistance, still others may be thin-sectioned castings, and in that case machinability is the property that has to be watched and maintained. Other castings may require various combinations of the partial list of properties mentioned, or all of them. Many foundries are limited to one base mixture from the cupola, because of the way the metal has to be poured throughout the day. Others have two base mixtures, and in some cases three are employed. Even with two or three types of base irons from the continuously-melting cupola, it is necessary to modify and change the properties of the base irons to suit specific casting requirements and specifications. The same reasons hold for metals produced in large batch-type furnaces, such as the air furnace.

The foundry usually produces a base metal that can be used in the majority of castings produced. This may contain small amounts of alloys and is then modified by further additions of alloy for special castings. For castings requiring different properties and compositions an additional smaller melting unit, such as the electric furnace, may be employed, either as a separate melting unit or in conjunction with the cupola, air furnace, Brackelsburg furnace, etc.

The alloys most commonly used are nickel, chromium, molybdenum, copper and (only fairly recently) titanium. Large quantities of silicon in the form of ferrosilicon, are used, but the resulting irons are not normally considered as alloy irons, unless the silicon content of the resulting metals is greatly in excess of about 3.00 per cent. Manganese in lesser quantities is used as ferromanganese, but here again the resulting metal is not usually considered an alloy iron unless the quantity present greatly exceeds about 1.25 per cent.

For ladle additions, nickel in the form of shot is used, while chromium, molybdenum and titanium are added in the form of low-melting-point ferroalloys. Copper is usually added as fairly small pieces of the scrap metal. For furnace additions, nickel is usually added as small pigs or squares, chromium as lump ferrochrome or in briquet form, molybdenum as ferroalloy or calcium molybdate, and copper usually as scrap metal. Nickel and chromium mal also be added by means of alloy-bearing pig irons.

The melting units used to produce the major proportion of alloy irons or the base metals from which the alloy irons are made are the cupola, air furnace and electric furnace. The Brackelsburg type of furnace probably will be used in increasing proportion in the future. The greater portion of alloy irons made today are produced with cupola-melted metal, because of the high efficiency and economy of this form of melting. During the past ten years particularly all phases of cupola operation and control have been im-

By Garnet P. Phillips *

Iron Grows

Alloys are better adapted to heat treatment than unalloyed irons and producers are constantly experimenting to find more serviceable metals

proved, so that today it is possible for foundrymen to produce consistently uniform cupola-melted metal.

Some of the automotive parts in which alloy irons are being increasingly used are cylinder blocks, cylinder heads, valve guides, valve seats, cylinder sleeves, cylinder liners, clutch pressure plates, exhaust manifolds, piston rings, brake drums and dies. Parts in which alloy-iron castings are more recently being employed are camshafts and crankshafts.

Automobile Cylinder Blocks

Present day automobile cylinder blocks require iron that is wear-resisting, dense and fine-grained, and that has a certain amount of corrosion resistance. Blocks are expected to render many thousands of miles service per year with no undue wear of the cylinders resulting. As a high rate of wear means loss of power and increased oil consumption, alloy irons have found an extensive field of usefulness in many of the automobile blocks produced today. The exhaust-valve seats of cylinder blocks need to be wear- and heat-resisting, which is an added reason for the use of alloy irons.

Table I shows four typical compositions of alloy irons used. The castings produced have metal sections of from 3/16-in. walls to bosses up to 2 in. in thickness. The weights of the castings range from 75 lb. to 275 lb.

It will be noted that small amounts of nickel and chromium are favored by the automobile plant metallurgists and engineers. Chromium is used to increase the hardness of the metal, particularly in the cylinder bores, where an annealing action takes place while the casting cools in the foundry. Increased wear resistance results from the higher hardness thus obtained. Some increase in corrosion resistance is also obtained, which is of importance at lower operating temperatures. Since chromium is a powerful carbide-forming element, it is customary to add a less powerful graphitizing agent, such as nickel or silicon or both, in small amounts to prevent the formation of massive carbides, refine the matrix, and to increase machinability. Copper is also used, usually in amounts less than 1 per cent, in automobile cylinder blocks, as it's effects are similar to those of nickel.

Molybdenum is used to increase hardness, although on a lesser scale than chromium, and to increase the strength and shock resistance of the metal. Castings that have a tendency —owing to design or casting technique—to crack are benefited by the addition of molybdenum, which increases the strength and shock resistance of the metal.

The alloy metals commonly used in automobile cylinder blocks usually have a silicon content ranging from 1.80 to 2.35 per cent, the quantity used depending on size, weight and cooling rate of the particular casting. The total carbon content usually ranges from 3.00 to 3.40 per cent. The phosphorus content is usually held below 0.20 per cent and very rarely runs over 0.30 per cent, as experience has shown that the higher ranges result in unsound, porous and brittle castings. The manganese content is usually held at from 5 to 7 times the sulphur content, to assure freedom of the metal from iron sulphides. The total alloy content is usually under 1.00 per cent, this upper limit being dictated by costs.

The data given for automobile cylinder blocks apply to blocks used in the light trucks that are produced in large numbers today.

Table 2. Truck, Bus and Tractor Cylinder Blocks

Analysis	1	2	3[1]	4	5
Silicon	2.00-2.25%	1.80-2.00%	2.25-2.45%	2.15-2.35%	2.20-2.40%
Total Carbon	3.15-3.35	3.20-3.40	3.10-3.40	3.10-3.35	3.20-3.40
Graphite	2.50-2.70	2.55-2.65	2.60-2.80	2.50-2.70	.....
Combined Carbon	0.65-0.85	0.65-0.75	0.50-0.70	0.60-0.70	
Sulfur	0.08-0.13	0.09-0.12	0.08 Max.	0.08 Max.	0.11 Max.
Phosphorus	0.15-0.21	0.14-0.18	0.16 Max.	0.16 Max.	0.17-0.22
Manganese	0.60-0.80	0.75-0.85	0.60-0.80	0.60-0.80	0.55-0.70
Nickel	0.10-0.20	1.25-1.35	0.10-0.30	None	0.55-0.65
Chromium	0.70-0.90	0.55-0.60	0.20-0.40	0.30-0.50	0.20-0.25
Molybdenum	1.00-1.10		0.20-0.40	0.35-0.55	.....
Copper	1.00-1.20				
Brinell	248-269	217-228	163-207	207-241	179-228
Transverse Bar Diam. & Centers—In.	1.20 x 18	1.20 x 12	1.20 x 18	1.20 x 18	1.20 x 18
Transverse Load—Lb.	3100-3300	4000-4200	2800-3200	2700-3200	2400-2900
Transverse Defl.—In.	0.33-0.44	0.12-0.14	0.29-0.34	0.25-0.32	0.24-0.34
Tensile PSI x 10^3	50-53	38-40	40-45	39-45	38-43
Type	Diesel	Gasoline	Gasoline	Gasoline	Gasoline

[1] Use cylinder liners in these blocks.

*Metallurgist, International Harvester Co.

Truck, Bus and Tractor Cylinder Blocks

Cylinder blocks used in trucks, buses and tractors, in which cylinder liners are not used, generally are required to have somewhat higher hardnesses in cylinder bores than automobile blocks. This is particularly true of the so-called "heavy-duty" type of commercial vehicles.

The five examples given in Table 2 are for blocks with metal sections of from 3/16-in. walls up to 2½-in. bosses and with weights ranging from 125 to 700 lb.

The silicon content of the metals used in truck, bus and tractor cylinder blocks usually ranges from 1.80 to 2.40 per cent, depending on metal sections and weights of the particular castings. The total carbon is usually run between 3.10 and 3.40 per cent. The phosphorus content is held below 0.22 per cent and usually below 0.20 per cent. The manganese content is normally about 5 to 7 times the sulphur content and ranges from 0.50 to 0.85 per cent.

The total alloy content may range from about 0.75 per cent up to 3.00 per cent. In most alloy cylinder blocks used in heavy-duty commercial vehicles the alloy content is considerably higher than that of automobile and light truck blocks. Nickel-chromium alloy combinations, in which the nickel content is from about two to three times the chromium content, are used. Nickel-chromium-molybdenum, chromium-molybdenum and nickel-chromium-molybdenum-copper alloy combinations are also used. The use of copper as a substitute for nickel is increasing, due to the lower cost of copper.

Table 3. Automobile, Truck, Bus and Tractor Cylinder Heads

Analysis	1	2	3	4
Silicon	2.15-2.35%	2.15-2.35%	1.95-2.15%	2.15-2.30%
Total Carbon	3.10-3.40	3.10-3.35	2.90-3.10	3.30-3.40
Graphite	2.50-2.70	2.50-2.70	2.30-2.50	2.70-2.90
Combined Carbon	0.60-0.70	0.60-0.70	0.60-0.70	0.50-0.70
Sulfur	0.10 Max.	0.08 Max.	0.07 Max.	0.12 Max.
Phosphorus	0.20 Max.	0.16 Max.	0.15 Max.	0.22 Max.
Manganese	0.50-0.70	0.60-0.80	0.65-0.85	0.50-0.70
Nickel	1.10-1.45	......	0.25-0.45	0.15-0.25
Chromium	0.45-0.65	0.30-0.50	0.40-0.60	0.10-0.20
Molybdenum	......	0.35-0.55	0.65-0.80	......
Brinell	207-241	207-241	229-241	190-220
Transverse Bar Diam. and Centers—In.	1.20 x 18	1.20 x 18	1.20 x 18	1.20 x 12
Transverse Load—Lb.	2400-2600	2700-3200	3300-3600	3200-3800
Transverse Defl.—In.	0.25-0.28	0.25-0.32	0.30-0.37	0.15-0.20
Tensile PSI x 10^3	35-40	39-45	45-52	32-38

Cylinder Heads

The metal used in cylinder-head castings must be pressure-resisting, heat-resisting and—in valve-in-head types—resistant to the pounding action of valves, particularly where valve-seat inserts are not used. As cylinder-head castings are rather intricate and fairly thin-sectioned, the metal used must have good castability and be machinable at fairly high machining speeds.

Table 3 shows four typical examples of metals used in cylinder head castings at the present time. It will be noted that nickel-chromium, chromium-molybdenum, and nickel-chromium-molybdenum alloy combinations are used.

In all cases chromium is used because of its ability to form stable carbides that are extremely heat-resistant. Nickel is used to prevent the formation of massive carbides and to help refine and toughen the metal. Molybdenum is used primarily to increase strength, at both ordinary and elevated temperatures.

The metal sections of the cylinder-head castings range from 3/16-in. walls to 1 in. bosses. The weights range from 50 to 165 lb.

The silicon content ranges usually from about 1.90 to 2.40 per cent, the total carbon from about 2.90 to 3.40 per cent, the sulfur up to 0.12 per cent and the manganese usually from about 0.50 to 0.80 per cent. The phosphorus is held at a maximum of 0.22 per cent and usually under 0.20 per cent. The total alloy content may range from about 0.25 up to 2.00 per cent, depending on the type of service in which the head is to be used. The automobile cylinder heads usually are produced with the lower-alloyed metals and the heavy-duty types with the more highly-alloyed irons.

The hardness of present-day cylinder heads is usually over 190 and up to about 250 Brinell.

Large marine diesel engine heads of much greater weight and with metal sections up to 2.5 in. require metal of much lower silicon content in order to maintain hardness and other physical properties. The data given in Table 4 shows the properties of such a metal.

Table 4. Marine Diesel Cylinder Heads

Analysis			
Silicon	0.90-1.10	Metal Sections—In.	⅝-2½
Total Carbon	3.00-3.20	Weight Range—Lb.	3000-4000
Graphite	2.30-2.50	Brinell Hardness	220-230
Combined Carbon	0.70-0.90	Tensile Strength—PSI	42,000-45,000
Sulfur	0.07-0.09	Transverse Diam.—In.	1.25-12.0
Manganese	0.60-0.80	Supports:	
Nickel	1.00-1.25	Load—Lb.	4500-5000
Chromium	0.10-0.20	Deflection—In.	0.110-0.125
Phosphorus	0.10-0.20		

Valve Guides

The property of greatest importance in valve guides is that of wear-resistance. The opinion is held by some that corrosion-resistance is of considerable importance in valve guide service. Since valve guides are generally machined from solid castings it is important to have dense metal in the interior of the castings. Table 5 shows the properties of two typical valve guide metals and data on the castings.

The metal sections or diameters of the castings range from 9/16 in. to 1 in. The weights of the castings range from 0.25 to 1 lb.

As can be seen from the data given

in Table 5, the metals used in valve guides are similar to or identical with the metals used in cylinder blocks. The heavier metal sections of the valve guides, as compared to the average cylinder block sections, are compensated for by the light weight of the valve-guide castings, which cool quickly after casting in the foundry.

Valve-Seat Inserts

As automotive service conditions have become increasingly severe it has been found advisable to employ separately-cast valve-seat inserts, made of metals with greater heat resistance or thermal stability and the ability to withstand deformation and scoring resulting from the pounding action of the valves. Alloy cast irons are fairly widely used for this service.

The insert metal should have the same coefficient of expansion as the cylinder block or head metal into which it is inserted. It is for this reason primarily that austenitic iron inserts are employed in aluminum cylinder heads and blocks. Table 6 gives properties of typical alloy-iron valve-seat inserts in use at present.

It will be noted that nickel, chromium and molybdenum are the alloys most commonly used in valve-insert castings. The No. 2 iron given in Table 6 is an austenitic alloy iron with a coefficient of expansion about the same as that of the aluminum in which it is inserted.

The metals used have varying degrees of heat resistance, but in general the more highly alloyed irons are the most resistant. All are fairly hard materials.

The castings are light in weight and have metal sections ranging from about ¼ to ⅜ in.

Table 6. Automobile, Bus, Truck and Tractor Engine Valve Seat Inserts

Analysis	1	2	3	4
Silicon	2.10-2.30%	1.25-1.50%	1.75-2.00%	2.15-2.30%
Total Carbon	3.05-3.15	2.80-3.10	3.20-3.40	3.20-3.40
Graphite	2.45-2.55	......	......	2.20-2.40
Combined Carbon	0.50-0.60	......	......	0.80-1.00
Sulfur	0.10 Max.	0.10 Max.	0.10 Max.	0.12 Max.
Prosphorus	0.20 Max.	0.20 Max.	0.20 Max.	0.25 Max.
Manganese	0.70-0.80	1.00-1.50	0.60-0.70	0.50-0.70
Nickel	0.40-0.60	12.00-15.00	1.25-1.50	0.15-0.30
Chromium	0.10-0.20	2.00-3.00	0.30-0.40	0.60-0.80
Molybdenum	1.10-1.20	......	0.35-0.45	......
Copper	......	5.00-7.00	......	......
Rockwell Hardness	"B" 103-109	"B" 90-100	"B" 96-102	"C" 35-45

Cylinder Sleeves and Liners

The use of cylinder sleeves and liners is becoming more prevalent in truck, bus and tractor engines. The name "cylinder sleeves" refers to "wet" inserted cylinders, while the designation "cylinder liner" refers to "dry" inserted cylinder liners. The use of sleeves and liners, in some cases along with valve-seat inserts, makes it possible to use high-grade alloy iron in the sleeves and liners while using ordinary soft gray iron in the cylinder blocks and crankcases.

Thus the rather complicated cylinder blocks are made with softer gray iron that is easily cast and machined, with no sacrifice but rather an increase in the quality of the finished engines. In some cases the sleeves and liners are used in the "as cast" or normalized condition, which means that the Brinell hardness is usually below 300, while in other cases the sleeves and liners are hardened and drawn, so that the Brinell hardness is above 450. The use of hardened sleeves and liners has proven well justified by the increased wear resistance obtained in service in (heavy-duty) bus, truck and tractor engines.

Data on typical cylinder sleeves and liners as produced at present are given in Table 7. The metal sections of the castings range from ⅜ to 1¼ in. The casting weights range from 7 lb. for small tractor engines to 150 lb. for large diesels.

Examination of the analyses shows that, in the pearlitic irons, the total carbon in practically all cylinder sleeves and liners is held between about 3.00 to 3.40 per cent. The silicon may be as high as 2.40 per cent in the light, thin-sectioned castings, and as low as 1.40 per cent in the heavier, thicker-sectioned castings. In the majority of cases the sulphur is held below 0.12 per cent and the phosphorus below 0.22 per cent. The manganese is run between 0.50 and 0.90 per cent. The total alloy content runs from about 2.65 per cent in sleeves that are hardened, to as low as about 0.75 per cent. Practically all types of alloy irons are in use: Nickel, nickel-chromium, nickel-chrome-molybdenum, chrome-molybdenum and nickel-molybdenum.

The sleeve and liner examples given in Table 7 are produced with metal melted in the cupola, electric furnace, air furnace and with combinations of these melting media.

Example No. 10 given in Table 7 is an austenitic iron called "Ni-Resist" on which patents are held by The International Nickel Co. It has a coefficient of thermal expansion that approximates that of the aluminum engine block in which the sleeves are used.

Clutch Pressure Plates

The service of clutch pressure plates is such that resistance to wear and scoring is of primary importance. Sta-

Table 5. Automobile, Truck and Tractor Engine Valve Guides

Analysis	1	2
Silicon	2.15-2.30%	1.90-2.10%
Total Carbon	3.30-3.40	3.20-3.40
Graphite	2.70-2.90	2.60-2.80
Combined Carbon	0.50-0.70	0.60-0.80
Sulfur	0.12 Max.	0.10 Max.
Phosphorus	0.15-0.22	0.20 Max.
Manganese	0.50-0.70	0.50-0.75
Nickel	0.15-0.25	1.00-1.50
Chromium	0.10-0.20	0.18-0.30
Brinell	200-230	210-240
Transverse Bar Diam. and Centers—Ins.	1.20 x 12	1.20 x 18
Transverse Load—Lb.	3200-3800	2500-2900
Transverse Deflection	0.11-0.17	0.25-0.30
Tensile PSI x 10^3	32-38	35-40

Table 8. Automobile, Bus, Truck and Tractor Clutch Pressure Plates

Analysis	1	2	3	4	5
Silicon	2.00-2.30%	2.15-2.25%	2.00-2.20%	2.15-2.30%	1.90-2.10%
Total Carbon	2.90-3.20	3.10-3.40	3.35-3.50	3.30-3.40	3.20-3.40
Graphite	2.40-2.60	2.75-2.95	2.75-2.90	2.70-2.90	2.60-2.70
Combined Carbon	0.60-0.80	0.30-0.40	0.50-0.70	0.50-0.65	0.60-0.70
Sulfur	0.08-0.10	0.10-0.14	0.10 Max.	0.12 Max.	0.10 Max.
Phosphorus	0.15-0.20	0.12-0.16	0.20 Max.	0.15-0.22	0.20 Max.
Manganese	0.60-0.70	0.50-0.70	0.50-0.70	0.50-0.70	0.50-0.70
Nickel	......	0.20-0.40	0.60-0.90	0.15-0.25	1.15-1.55
Chromium	0.15-0.25	0.20-0.40	0.15-0.25	0.10-0.20	0.55-0.75
Molybdenum	0.35-0.45	......	......	......	......
Titanium	0.05-0.10	......	......	......	......
Brinell	223-248	187-228	180-220	207-223	207-241
Transverse Bar Diam. and Centers—In.	1.20 x 18	1.20 x 18	1.20 x 18	1.20 x 12	1.20 x 18
Transverse Load—Lb.	2800-3000	2300-2500	2200-2500	3200-3800	2500-2900
Transverse Defl.—In.	0.33-0.38	0.20-0.28	0.25-0.32	0.10-0.15	0.24-0.32
Tensile PSI x 10^3	40-48	32-37	30-35	32-38	38-42

bility under heat and fairly high strength are also necessary.

As speeds and rates of acceleration have been stepped up markedly in the past few years, the service imposed on clutch pressure plates has been made more and more severe. In addition, it has become increasingly necessary that the castings be made almost perfectly sound throughout and, on types that are not machined all over, that the castings be as nearly true to pattern as possible, in order that balancing may be effected with a minimum removal of stock.

Table No. 8 shows the compositions and properties of typical present day clutch pressure plates. The metal sections of the castings range from ½ to 1¼ in., and weights range from 8 to 40 lb.

The silicon content of the metals used in clutch pressure plates ranges from about 2.00 to 2.30 per cent. The carbon content is usually held at over 3.00 and under 3.50 per cent, as irons with this amount of carbon and corresponding graphite, of from 2.50 to 2.90 per cent, have been found to have excellent wear resistance in clutch plate service. The sulphur content is usually held under 0.12 per cent, with manganese at from about 5 to 6 times the sulphur content. The phosphorus is usually held under 0.20 per cent.

The total alloy content may range from about 0.40 up to 2.00 per cent, the higher alloy metals being used in heavy-duty engines. Chromium is used in practically all alloy-iron clutch plates for its ability to harden the metal through the formation of stable carbides that resist dissociation due to heat. Molybdenum is used principally for its outstanding ability to strengthen and toughen the metal, while nickel is used to prevent massive carbide formation, thus promoting machinability and improving strength properties somewhat.

The Brinell hardness ranges from about 190 to 250. The range of strengths used is quite large and depends on the type of service, metal sections and design of casting.

Exhaust Manifolds

Exhaust manifolds have to withstand the effects of the hot exhaust gases, which cause oxidation and growth, resulting in cracking of the castings. In automobile engines, the operating temperatures of the exhaust manifolds are usually not high enough to necessitate the use of very highly alloyed irons, although there are some exceptions to this statement. As the compression and horsepower are increased, the operating temperatures of the exhaust manifolds usually increase, so that on many of the large commercial vehicle engines we find fairly highly alloyed pearlitic irons and still more highly alloyed austenitic irons employed.

Table 9 shows typical compositions and properties of various types of exhaust manifolds in use on present-day engines.

Examination of the compositions of Table 9 shows that chromium is the alloying element common to all. This is to be expected in castings that must

Table 7. Bus, Truck and Tractor Engine Cylinder Liners and Sleeves

Analysis	1	2	3	4	5	6	7	8	9	10
Silicon	1.90-2.10%	2.00-2.20%	2.00-2.20%	2.20-2.40%	2.10-2.30%	2.20-2.40%	2.15-2.30%	1.60-1.80%	1.40-1.60%	1.25-2.00%
Total Carbon	3.20-3.40	3.00-3.20	3.00-3.20	3.00-3.20	3.10-3.30	3.00-3.20	3.30-3.40	2.90-3.10	2.90-3.10	2.60-3.00
Graphite	2.40-2.60	2.20-2.35	2.10-2.40	2.20-2.50	2.40-2.80	2.30-2.60	2.70-2.90	2.25-2.40	2.25-2.35	......
Combined Carbon	0.75-0.90	0.75-0.90	0.60-0.90	0.60-0.80	0.50-0.70	0.50-0.70	0.50-0.65	0.70-0.85	0.75-0.85	......
Sulfur	0.10 Max.	0.10 Max.	0.08-0.10	0.10-0.12	0.10-0.13	0.08-0.12	0.12 Max.	0.08-0.09	0.08-0.09	0.04-0.12
Phosphorus	0.20 Max.	0.20 Max.	0.08-0.10	0.16-0.20	0.15-0.20	0.12-0.17	0.22 Max.	0.25-0.30	0.25-0.35	0.04-0.30
Manganese	0.55-0.75	0.50-0.70	0.70-0.90	0.70-0.90	0.70-0.90	0.70-0.90	0.50-0.70	0.45-0.55	0.45-0.55	0.80-1.30
Nickel	1.80-2.20	0.20-0.40	0.40-0.60	......	0.60-0.80	0.30-0.50	0.50-0.65	0.75-1.00	1.25-1.35	12.00-15.00
Chromium	0.55-0.75	0.20-0.40	0.80-1.00	0.20-0.30	......	0.30-0.50	0.11-0.20	......	0.20-0.30	2.00-3.50
Molybdenum	......	0.40-0.60	0.40-0.60	0.90-1.10	0.60-0.80	0.30-0.50	......	......	......	......
Copper	......	......	......	......	......	......	......	......	......	5.00-7.00
Brinell: As Cast	212-241	241-286	(As Cast Or Normalized or Annealed)							
Brinell: Hardened	480-520	450-550	286-311	269-286	241-262	248-277	190-220	215-225	220-235	150-200
Transverse Bar Diam. and Centers—In.	1.20 x 18	1.20 x 12	1.20 x 12	1.20 x 12	1.20 x 12	1.20 x 12	1.20 x 12	1.20 x 12	1.25 x 12	......
Transverse Load—Lb.	2400-2800	4200-5000	5000-5900	6000-6500	5000-5600	4600-5300	3200-3800	4000-4500	4500-5000	......
Transverse Deflection—In.	0.20-0.30	0.15-0.20	......	......	......	......	0.15-0.20	0.12-0.14	0.11-0.125	......
Tensile PSI x 10^3	37-42	42-50	50-60	55-65	46-54	46-54	32-38	40-45	43-48	25-30
Type Engine	Gasoline	Diesel	Diesel	Diesel	Diesel & Gasoline	Gasoline	Gasoline	Gasoline	Diesel	Aircraft Aluminum Crankcase

Table 9. Automobile, Bus. Truck and Tractor Exhaust Manifolds

Analysis	1	2	3	4	5
Silicon	2.00-2.25%	1.80-2.20%	2.00-2.15%	1.80-2.00%	1.70-2.10%
Total Carbon	2.75-3.20	3.30-3.50	3.30-3.40	3.20-3.40	2.80-3.10
Graphite	......	2.70-2.90	2.70-2.80	2.60-2.70	2.00-2.50
Combined Carbon	......	0.50-0.70	0.50-0.70	0.60-0.70	0.60-0.80
Sulfur	0.12 Max.	0.10-0.15	0.10 Max.	0.09-0.12	0.10 Max.
Phosphorus	0.20 Max.	0.18-0.23	0.20 Max.	0.14-0.18	0.20 Max.
Manganese	0.65-0.90	0.50-0.70	0.50-0.70	0.70-0.85	0.80-1.25
Nickel	......	......	1.65-1.85	1.25-1.35	13.00-15.00
Chromium	0.25 Max.	0.35-0.40	0.50-0.70	0.35-0.45	1.50-2.50
Molybdenum	0.50 Max.	0.35-1.00	......	......	......
Copper	......	......	......	......	5.00-7.00
Brinell	255 Max.	200-248	215-250	212-228	140-170
Transverse Bar Diam. and Centers—In.	0.875 x .12	1.25 x .12	1.20 x .18	1.20 x .12	1.20 x .18
Transverse Load—Lb.	4200-4600	3600-4600	2600-3000	4000-4200	2200-2600
Transverse Deflection —In.	......	0.12-0.15	0.28-0.32	0.12-0.14	0.40-0.60
Tensile PSI x 10^3	47.5-52.3	38-50	38-43	37-40	25-30

resist oxidation and growth almost exclusively.

As manifold castings are thin-sectioned, we find that very low silicons and carbons are not normally employed, as chilled, unmachinable castings would result in the pearlitic irons. Phosphorus is usually kept below 0.20 per cent with manganese and sulfur held at a ratio of 5 or 6 to 1. The total alloy content may range from about 0.75 up to 2.35 per cent. Nickel-chrome and chrome-molybdenum alloy combinations are used. Chromium forms stable carbides that resist growth and oxidation. Nickel is used to promote machinability by preventing the formation of massive carbides, and to refine the pearlite and thus strengthen the metal. Molybdenum is used primarily to increase strength at both ordinary and elevated temperatures.

For very heavy-duty service the austenitic type of iron, such as No. 5 in Table 9, is used. This material has been found to give very satisfactory service, providing proper design is followed and providing that allowance is made for its high thermal expansion. Slip joints are usually used to allow the metal to expand and contract without setting up undue stresses that would cause cracking and failure. This material is also used in exhaust-port flanges on aircraft engines with aluminum-alloy crankcases and cylinder heads.

The metal sections of the exhaust manifolds described range from 3/16-in. walls to ¾-in. flanges. The casting weights range from 15 to 88 lb.

Piston Rings

The increasing use of harder cylinder wall metals in blocks, sleeves and liners has caused the introduction of alloy piston rings to withstand the more severe service conditions imposed on them. In some cases hardened alloy piston rings are used, and considerable experimentation is being carried on with this type. It remains to be seen whether hardened rings will be necessary, i. e., rings with a Brinell hardness of over 400, or whether alloy rings of a Brinell under 300 will be generally used.

Table 10 shows three alloy irons used in piston rings, with the physical properties of the metals. The metal sections of the ring castings range from ⅛ to 1 in. and weights range from 0.1 up to 30 lb. for large diesel engines.

The silicon content ranges from 1.50 per cent for the large, heavy-sectioned rings up to 2.80 per cent for the small, light thin-sectioned rings. The total carbon ranges from 3.50 to 3.75 per cent, with a correspondingly high graphite content. The sulfur content usually is held below 0.10 per cent, with manganese at from 7 to 10 times the sulfur content. The phosphorus content ranges from about 0.25 to 0.50 per cent. The phosphorus content is considerably above that of the majority of automotive castings and is made so high because of the light weight and thin sections of automotive piston ring castings.

The alloy combinations shown consist of nickel-chrome-molybdenum, chrome-molybdenum, and titanium-vanadium. Other alloys and combinations are being developed and tested at the present time. It is probable that a fairly wide range of alloy iron pis-

Table 10. Bus, Truck and Tractor Engine Piston Rings

Analysis	1	2	3
Silicon	2.60-2.80%	2.60-2.80%	1.50-1.90%
Total Carbon	3.60-3.75	3.60-3.75	3.50-3.75
Graphite	3.05-3.30	3.05-3.30	2.80-3.10
Combined Carbon	0.45-0.55	0.45-0.55	0.50-0.80
Sulfur	0.06-0.09	0.06-0.09	0.06-0.10
Phosphorus	0.30-0.40	0.30-0.40	0.30-0.50
Manganese	0.60-0.80	0.60-0.80	0.50-0.80
Molybdenum	......	0.15-0.25	0.25-0.60
Chromium	......	0.15-0.25	0.25-0.60
Titanium	0.10-0.20	......	......
Vanadium	0.10-0.15	......	......
Nickel	......	......	0.50-1.50
Brinell	......	......	190-220
Rockwell	"D" 40-54	"D" 40-45	"B" 92-99
Transverse Bar Diam. and Centers—In.	......	......	0.875 x .12
Transverse Load—Lb.	......	......	1300 1600
Transverse Deflection —In.	......	......	0.14-0.16
Tensile	22-26	22-26	30-45

ton rings will be available and in more general use in the near future.

Brake Drums

Gray cast irons and particularly alloy gray irons have been found from experience to have properties that make them excellent materials for brake drums.

In the heavy-duty truck and bus fields the use of alloy cast iron brake drums has been common for a number of years. More recently alloy cast irons have been adopted in the other automotive fields.

Drums must remain cylindrical, must not undergo undue structural breakdown, must not expand to the point where brakes are not effective, and must not "heat check or crack" unduly in heavy-duty service. In short, brake-drum service, particularly on heavy-duty, high-speed vehicles, is one of the most severe that alloy irons are called upon to perform.

The structure and graphite content of alloy gray irons make it an excellent material, since its frictional properties, along with proper brake linings, are such that the brakes are effective even with heavy loads and at high speeds. However, it is not an excellent heat conductor and it is usually necessary to provide ventilation and as much surface as possible for heat radiation on the exterior of the drums.

Table 11 shows typical compositions of brake drum metals in use at present with their properties. The metal sections of the brake drum castings range from ¼ to 1¾ in. and weights range from 15 to 195 lb.

Brake drums for aircraft service are machined all over, in order to minimize weight and to secure balance. As quite thin drums are the result, it is necessary to use fairly high-strength, shock-resisting iron. In the example given in Table 11, a nickel-molybdenum iron of high hardness and strength is used. In the automobile, bus, tractor and truck fields, nickel, molybdenum and nickel-chrome irons are commonly used.

The silicon content of the irons used may range from as low as 1.60 per cent to 2.90 per cent, depending on casting weight and total carbon employed. The total carbon content ranges from about 2.80 to 3.40 per cent. Phosphorus is held below 0.30 per cent and in the majority of cases below 0.20 per cent, in order to assure castings that are free from porosity, shrinkage cavities, etc., and also to obtain maximum toughness.

The sulfur content may be as high as 0.14 per cent in some cases and held to very low limits in others. The manganese content is held at from five times the sulfur content up to about 15 times the sulfur content.

The hardness may range from 180 Brinell for less severe applications up to 255 for heavy-duty service. The tensile strength of the metals used ranges from about 35,000 up to about 60,000 lb. per sq. in.

Dies

The use of alloy cast iron dies for forming, bending, stamping, drawing and forging has increased rapidly in the last few years. By the use of alloyed irons it is possible to obtain fine grained, tough, high strength irons in practically any metal section employed in dies and to obtain the high polish that is necessary. Such alloyed iron dies have excellent wear resistance, do not gall or streak the metal being worked, and they are economical as compared to plain iron or steel dies in the applications that have been developed. The hardness of the metal may be run as high as may be machined, if the dies are to be used in the "as cast" or normalized condition, and they may be heat-treated by oil quenching and drawing to a hardness of over 500 Brinell in dies of small size.

Table 12 shows some typical compositions of alloy iron dies used in the automotive industries. The examples shown are representative but do not cover all types of alloy combinations used.

In example No. 2 the hardened dies are oil quenched from 1550 deg. F. and drawn at 350-400 deg. F. Example No. 3 is for metal oil quenched from 1575 deg. F. and drawn at 950 deg. F. In example No. 5 the hardness and tensile values are for 2-in. sections. Example 6 was heat treated by oil quenching from 1575 deg. F. and drawing at 800 deg. F. In all cases the dies are held at the quenching temperature for about one hour per inch of metal section.

The metal sections of the examples shown in Table 12 range from 2 to 15 in. and the weights from 50 lb. to 15 tons.

The compositions used for dies vary greatly for various applications and weights. In some cases low silicons and medium carbons are employed. In other cases fairly high silicon, low carbon irons are used, and in others low silicon high carbon metal is preferred. Nickel-chrome, nickel-chrome-molybdenum, and nickel-molybdenum and molybdenum alone are all used. In practically all cases the phosphorus content is kept below 0.20 per cent, and in many applications below 0.10 per cent.

The performance records of alloy iron dies have been very satisfactory. They usually are many times those of

Table 11. Automobile, Bus, Truck, Tractor and Aircraft Brake Drums

Analysis	1	2	3	4	5	6	7
Silicon	2.20-2.40%	2.15-2.25%	1.60-1.80%	1.70-2.00%	1.80-2.20%	1.90-2.90%	1.90-2.10%
Total Carbon	3.10-3.40	3.10-3.40	2.90-3.10	3.30-3.50	2.90-3.10	2.80-3.00	3.20-3.40
Graphite	2.20-2.40	2.75-2.95	2.25-2.40	......	2.30-2.50	2.00-2.40	2.60-2.70
Combined Carbon	0.70-0.90	0.30-0.50	0.70-0.85	......	0.60-0.80	0.60-0.80	0.60-0.70
Sulfur	0.10-0.12	0.10-0.14	0.08-0.09	0.09-0.12	0.06-0.10	0.05 Max.	0.10 Max.
Phosphorus	0.11-0.23	0.12-0.18	0.25-0.30	0.15-0.20	0.06-0.10	0.10 Max.	0.20 Max.
Manganese	0.60-0.80	0.50-0.70	0.45-0.55	0.50-0.70	0.60-0.80	0.60-0.80	0.50-0.70
Nickel	0.65-0.85	0.20-0.40	0.75-1.00	1.25-1.50	......	......	1.15-1.55
Chromium	......	0.20-0.40	......	0.50-0.70	......	......	0.55-0.75
Molybdenum	0.65-0.85	......	......	......	0.35-0.45	0.50-0.55	......
Brinell	241-255	187-228	215-225	......	228-248	180-255	207-241
Transverse Bar Diam. and Centers—In.	1.25 x .12	1.20 x .18	1.25 x .12	1.25 x .12	1.25 x .12	1.20 x .12	1.20 x .18
Transverse Load—Lb.	4700-5100	2300-2500	4000-4500	4000-4500	4600-5000	5700-6300	2500-2900
Transverse Deflection—In.	0.15-0.17	0.20-0.28	0.12-0.14	0.10-0.20	0.15-0.165	0.13-0.16	0.24-0.32
Tensile PSI x 10^3	46-50	32-27	40-45	36-42	46-50	54-61	38-42
Type	Aircraft	Auto	Bus and Truck	Tractor	Auto and Truck	Truck and Bus	Truck and Bus

Table 12. Typical Examples of Alloy Iron Dies

Analysis	1	2	3	4	5	6
Silicon	1.25-1.50%	2.00-2.40%	1.20-1.40%	1.00-1.50%	2.00-2.10%	1.00-1.50%
Total Carbon	2.80-3.10	2.60-2.90	2.80-3.00	2.80-3.20	2.40-2.50	3.00-3.40
Graphite	......	1.90-2.10	......	2.20-2.40	1.80-1.90	......
Combined Carbon	......	0.65-0.80	......	0.60-0.80	0.60-0.70	......
Sulfur	0.08-0.11	0.10 Max.	0.10 Max.	0.10-0.12	0.05-0.08	0.12 Max.
Phosphorus	0.16-0.20	0.20 Max.	0.10 Max.	0.10-0.15	0.04-0.06	0.20 Max.
Manganese	0.60-0.80	0.55-0.70	0.70-0.90	0.70-0.90	0.70-0.90	0.60-0.90
Nickel	1.50-2.00	1.40-1.70	1.60-1.90	......	0.80-1.00	5.00-6.00
Chromium	0.50-0.60	0.35-0.50	0.30-0.40	......	0.10-0.20	0.50-0.60
Molybdenum	......	0.40-0.60	......	0.70-0.90	1.00-1.20	......
Brinell (As Cast) (1) (Small Dies Hardened) (2)	200-240	240-270 (1) 450-550 (2)	Heat Treated 300-340	240-270	310-340	300-320
Transverse Load—Lb.	......	3200-3600	......	1.25 x .12	1.25 x .12	......
Transverse Load—Lb.	......	3200-3600	......	5000-5400	7000-7700	......
Transverse Deflection—In.	......	0.22-0.29	......	0.15-0.17	......	......
Tensile—PSI x 10^3	40-50	55-65	75-90	46-50	60-65	50-65
Type	Forming	Forming, Hot Bending	Drawing	Drop Forging	Hot Forming	Heavy Duty Drawing

plain iron dies, and in certain applications equal the performance of more costly special die steels. As experience is gained it is to be expected that still more extensive use will be made of alloy irons in die service.

Camshafts

The application of alloy iron camshafts is comparatively recent and is not widespread as yet. However, since alloy camshafts now in use seem to be giving very satisfactory service and as the cost of producing the finished camshafts is materially lessened by the use of alloy iron castings, it is probable that applications will extend rapidly.

Probably the principal requirement in camshaft service is wear resistance, particularly at the cam tips. Medium strength, rigidity and machinability are also important, the latter at the bearing areas, gear blank and gear mounting areas. Alloy irons for camshaft service are usually such that in the slower cooling portions of the casting Brinell hardnesses of from 275 to 320 are obtained, while the cams are hardened to from 400 to about 500 Brinell. The cams may be cast against metal chills or heated to above the critical by selective heating and air-cooled to obtain the desired hardness, or they may be air-cooled quickly after casting to obtain the cam hardness desired.

Nickel, chrome, molybdenum and copper are employed in various combinations to obtain the desired results. Table 13 shows two examples of metal used in camshaft service.

Crankshafts

Alloy cast iron has been used in crankshafts in slower speed engines, compressors, etc., for a few years, but it is only recently that it has been employed in the higher-speed engines.

As bearing areas have been increased and larger, heavier crankshafts employed, it has become easier to produce satisfactory crankshafts from castings, with a considerable saving in die and machining costs.

In crankshaft service a certain degree of strength is required, depending largely on design. The hardness required has gradually been increased as service conditions have become more severe. The fatigue resistance, impact resistance and torsional strength of the

Table 13. Metals Used in Camshafts

Analysis	1	2
Silicon	2.00-2.20%	1.85-2.05%
Total Carbon	3.00-3.20	3.10-3.30
Graphite	2.40-2.60	
Combined Carbon	0.60-0.90	......
Sulfur	0.08-0.10	0.10 Max.
Phosphorus	0.08-0.10	0.20 Max.
Manganese	0.70-0.90	0.50-0.70
Nickel	0.40-0.60	1.00-1.25
Chromium	0.80-1.00	0.50-0.70
Molybdenum	0.40-0.60	0.40-0.60
Brinell	280-310 / 500-530 (Cams)	220-260 / 475-510
Transverse Bar Diam. and Centers—In.	1.20 x 12	1.20 x 18
Transverse Load—Lb.	5600-5900	2800-3200
Transverse Deflections—In.	......	0.28-0.34
Tensile—PSI x 10^3	50-60	45-55

metals used are important, and the vibration-damping capacity is also quite an important factor.

Alloy cast irons that are in use generally have Brinell hardness of the order of 300 and tensile strength in the range of 50,000 to 75,000 lb. per sq. in. The modulus of elasticity in the working range employed will usually be over 17,000,000 lb. per sq. in.

Some examples of alloy cast irons used are given in Table 14. The weights of the castings range from 40 lb. to a ton for large diesel engines, and metal sections range from ¾ to 4 in.

As can be seen from the compositions given, the carbon content ranges from about 3.00 per cent down to 2.40 per cent. Whether or not the trend will be toward still lower carbon content probably will be determined by service results and experience. A large number of producers of alloy metals are continuously experimenting with various types of irons and cast steels, and intermediate products that have no orthodox classification at present. Some of the present alloy iron crankshafts are heat treated and some are not.

Table 14. Alloy Irons Used in Crankshafts

Analysis	1	2	3	4
Silicon	2.40-2.80%	2.00-2.25%	1.10-1.50%	1.90-2.10%
Total Carbon	2.40-2.90	2.80-3.10	2.90-3.10	2.80-3.10
Graphite	1.80-2.10	2.10-2.20	2.10-2.20	2.00-2.20
Combined Carbon	0.60-0.90	0.70-0.85	0.80-0.90	0.75-0.90
Sulfur	0.04-0.07	0.10 Max.	0.10 Max.	0.10 Max.
Phosphorus	0.05-0.08	0.20 Max.	0.20 Max.	0.20 Max.
Manganese	0.80-1.00	0.60-0.80	0.80-1.00	0.60-0.75
Nickel	1.00-1.25	1.50-2.00	......	1.90-2.10
Chromium	0.10-0.20	0.20 Max.	0.10-0.30	0.20 Max.
Molybdenum	1.00-1.25	0.60-1.00	0.40-0.60	0.90-1.20
Copper	......	0.10-0.20	1.00-1.50	......
Brinell	290-320	280-320	250-290	280-320
Transverse Diam. and Centers—In.	1.20 x .12	120 x .18	120 x .18	1.20 x .12
Transverse Load—Lb.	7000-7700	4300-4800	2900-3400	5000-5300
Transverse Deflection —In.	......	0.30-0.42	0.31-0.28	0.10-0.15
Tensile PSI x 10^3	60-75	60-70	52-60	50-55

Force-Feed Lubrication Has Led to New Practice in Oil-Grooving

(*Continued from page* 728)

inner end is counterbored to 3/16 in. or so.

The provision for oiling the crankpin bearing in the Chevrolet is rather different from that in the majority of engines. This engine has what is known as pressure-stream lubrication, a stream of oil from a nozzle being directed into a dipper, at the back of which there is a hole through the connecting-rod cap. At the inner end of the hole through the cap there is a recess in the bearing which presents a certain oil capacity. A central circumferential groove extends all around the bearing. At the parting lines there is relief which extends the whole length of the bearing. Over the greater part of the bearing width the relief is quite wide, but at the ends it narrows down. The wide relief "grooves" are intended to spread the oil over the length of the bearing.

Piston-pin bearings are lubricated either by pressure from the crankshaft bearings or else by spray. When this bearing is pressure lubricated it does not have any oil grooves, as a rule. The oil enters the bearing through the oil hole in the shank of the connecting-rod and is distributed over the entire bearing surface by the pressure of feed and the pumping action of the bearing. In some cases the "rifle-drilled" oil hole extends through a central enlargement of the web of the connecting-rod shank, but in the Cadillac and the Pierce-Arrow it extends through an enlargement at the junction between the web and one of the flanges. When the bearing is spray-lubricated, a fairly large size hole is drilled through the top of the small end of the connecting rod and is countersunk so it will catch as much as possible of the oil dripping from the piston head. As the oil hole extends through both the small end of the rod and the bushing, the latter must be secured in the small end of the rod so it cannot turn therein. Piston-pin bushings now are often made of flat stock and rolled up into cylindrical-shell form.

Where the piston-pin turns in the piston bosses, oil is supplied to the bearings through holes drilled in the top of the bosses, which may catch some of the spray and oil running down the inner sides of the piston skirt, or else communicate with the groove of the oil scraper ring immediately above the bosses, so that some of the oil scraped off the cylinder wall finds its way to the bearing surfaces of the piston pin. With aluminum pistons the bearings in the bosses are neither bushed nor grooved. Where cast iron pistons are used, bronze bushings are provided, as a rule. An example is the Chevrolet piston, in which the bearings in the bosses are oiled through an oil hole in the top and the oil is distributed by an oil groove extending lengthwise at an angle through the oil hole.

Fiat 1935 Production Tops That of 1934

In the recent annual report of the Fiat concern the president stated that the 1935 production exceeded that of 1934 and represented a value of one billion lire ($79,000,000). The number of employes at the end of the year was 44,000, as compared with 30,000 in 1934. Export business increased 54 per cent.

The Horizons of Business

—By Joseph Stagg Lawrence

A Lesson in Economics

MAY is the fifth month of the calendar and the seventh month of the present automobile year. In the annual cycle of automobile production it has taken the place formerly held by July. In other years before the show date was advanced, the season, by July, was well along in its decline. The seventh month of the current automobile year is taking extraordinary liberties with the seasonal pattern which previous years have traced.

Production for the first three weeks in May seems to have maintained the volume reached at the end of April, i.e. about 120,000 units per week. Allowing for a drop of 20 per cent during June this suggests a production of 2,542,000 units for the first six months of the calendar year compared with 2,373,000 in the previous year, an increase of 7.2 per cent. Registrations for April on the basis of preliminary figures seem to be 11 per cent ahead of 1935. For the first four months registrations are approximately 15 per cent better than in the corresponding period in 1935.

In attempting to estimate the improvement which the current year may show over 1935 the gain in registrations for the month of April strikes a half way point between the six months' gain in production and four months' gain in registrations. On logical grounds 11 per cent seems a reasonable estimate at this stage of the improvement which may be anticipated over 1935. This would show an automobile year of 4,643,000 units.

An Ungrateful World

The automobile industry has been the bellwether of recovery. It led the way in 1933 and has turned in a consistently agreeable performance with little sign of faltering in the interval. The record is remarkable for many reasons not the least of which is its repudiation of a fallacy which, by virtue of official sponsorship, wears the trappings of valid economic principle. This aberration holds that manufacturers who have reduced costs have not been serving their fellow men too well since a reduction in costs means reduced incomes to workers and producers of raw materials and hence a reduction in purchasing power. The obvious reverse urges an identity between true public welfare and rising costs since the producer who tolerates higher costs is really increasing community buying power and thus promoting prosperity.

Neanderthal executives of successful enterprise have, it is suspected, succeeded largely because they could make better mousetraps than their competitors at a lower cost. These are the men that the business world has respected. To them have gone the laurels of victory. With truly reactionary injustice the public has wasted little sympathy upon the producer who was unable to match the price and quality of his competitors. It seems now in the light of advanced economic principle that the true benefactors of mankind are the managers whose enterprises are buried in the Potter's Field of business. These are the corporations whose executives tried to get the highest possible price for their products, willingly curtailing output in order to get more from fewer buyers, thus "increasing the purchasing power" which was spread back along the line of production. The only difficulty with these benign ventures is that they revealed an appalling mortality rate. A cynical and ungrateful world not only bit the hand that fed it "higher purchasing power" but actually forced the owner to starve to death.

Benevolence Versus Recovery

Though these observations be faintly sarcastic they are also pertinent. The business and financial world is less sure of the continued upward course of recovery than it has been for some months. Industries of which great performances were anticipated are falling short of their goals. Construction and its allied branches, although doing well in relation to last year's volume, reveal disturbing weakness. Some of the trade journals in the building field had predicted from two to 400 per cent increase in residential construction. A Washington sunshine agency which, if memory serves us, was called the Committee for Economic Recovery predicted the construction of 450,000 homes in 1936 as compared with a little more than 100,000 in 1935.

F. W. Dodge figures for 37 states for April show a gain in residential construction for the month of less than 60 per cent. The latest bulletin of the National Association of Real Estate Boards shows a steady and rather alarming decline in real estate transactions since the first of the year. Here is an industry which with one exception has had a thorough application of the novel theory that prosperity is best promoted by high costs of production. The exception is the interest charge on mortgages. The government seems to have done everything that a government could do to stimulate this industry—provided we accept the principle that higher costs constitute a stimulant on the ground that they permit the various elements of production to share in higher unit returns.

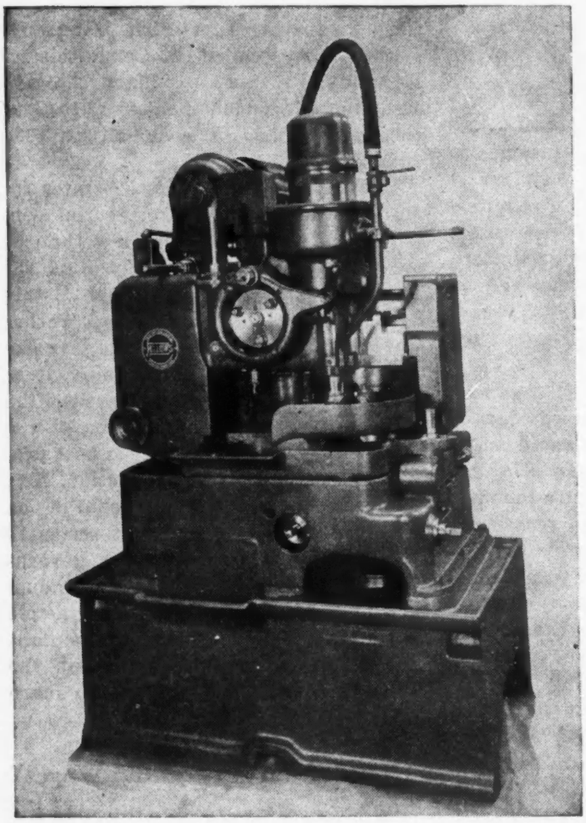
Surrender on "Prevailing Wages"

PWA contracts are all subject to the payment of maximum local wages for labor. When the huge $4,880,000,000 relief fund was jammed through Congress a year ago a bitter fight developed over the rates of pay for workers without jobs. Organized labor insisted that "prevailing" wage rates must be paid. This meant the nominal union rate which had been honored in the breech during the depression years. After ringing proclamations of defiance had been hurled at high pay advocates from the front stoop of the government it retired and ignominiously capitulated to prevailing wage demands on every count.

If this were merely a bit of political obeisance to conciliate a powerful group of voters it could be charged to necessity. The seriousness of the concession and the effect of the principle of higher purchasing power via higher costs of production is in process of demonstration. Construction which, it was hoped, would join the automobile industry in promoting recovery is not realizing its possibilities. Excessive government aid

(Turn to page 746, please)

NEW DEVELOPMENTS
Automotive Parts, Accessories and Production Tools



Front view Fellows Gear Shaper

Special Fellows Gear Shaper For Gap Type Cutters

The Fellows Gear Shaper Co., Springfield, Vt., has placed on the market a new gear shaper which is arranged especially for using a new cutter known as the "gap-type." This cutter is adapted to the rough and finish cutting of external spur and helical gears in one operation. The teeth on the circumference of the cutter are interrupted by one or more gaps, depending on the diameter and character of the work, making it possible to load and unload the work without withdrawing the tool.

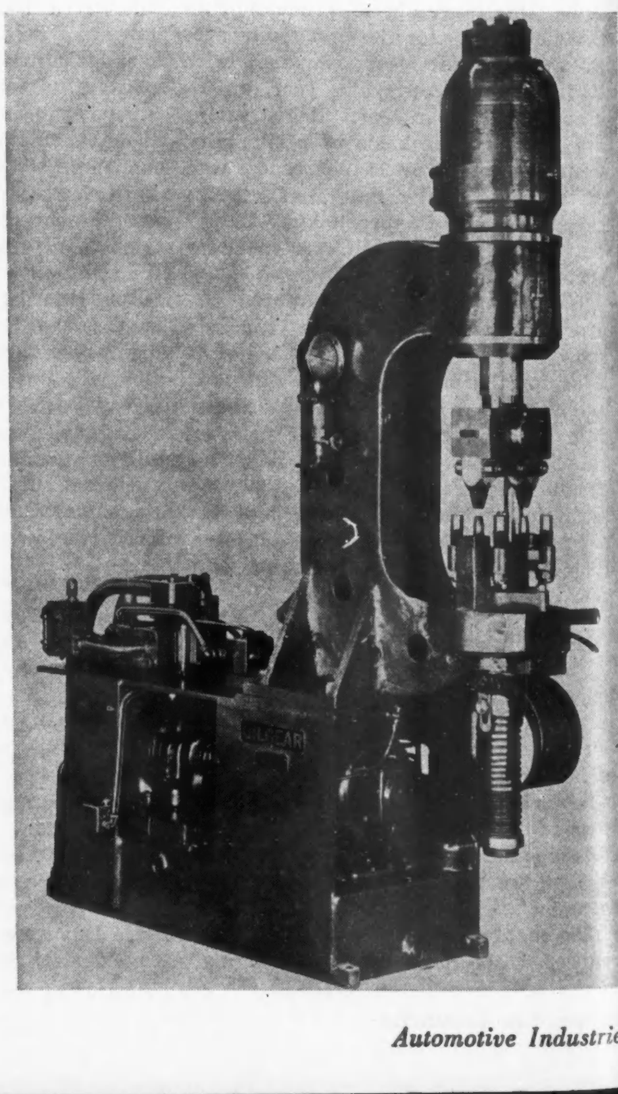
This machine differs from the regular gear shaper in that it is arranged with electrical control for timing the rotation of the cutter spindle. The electrical equipment comprises a constant speed motor, motor starter with thermal overload protection, interlocking contactors, a push button control station, an automatic stop for use with regular cutters and a cam-operated limit switch.

Electric Hydraulic Riveter

The Hanna electric hydraulic riveter illustrated is equipped with an Oilgear fluid power pump, direct driven by an electric motor through a flexible coupling. Maximum pressures may be regulated to the work, thus holding power consumption to a minimum and avoiding distortion of the work by reason of excess tonnage. At the maximum pressure of 3000 lb., this riveter exerts 80 tons pressure on the dies. The reach and gap may be varied to suit the work. This machine is a recent product of the Hanna Engineering Works, Chicago, Ill.

Electric Eye Controls Forging Heater

The American Car and Foundry Company, 30 Church St., New York City, has developed the No. 4, three-electrode a.c.f. Berwick type forging heater used in some of the large auto-



80-Ton Riveter

Union Cold Drawing

. . . MAKES "AUTOMATICS" MORE EFFICIENT

• The efficiency of Union Cold Drawn Steels in automatic screw machine operations is evident the instant these straight, accurately sized, bright finished bars are inserted into the feed tubes. They pass through the feed mechanism and collets smoothly without obstructions due to scale, crookedness or other imperfections. Their straightness and close accuracy to size promote uniform and certain feeding of the stock.

As drills, forming and other tools go into action, the increased machinability of Union Cold Drawn Steels gives opportunity for the best operation of any type of automatic screw machine. Higher speeds are attained and power is saved. Tool grinding, tool changes and idle time are reduced. Completed parts have a smooth, bright finish. Faster and better production at lower cost is the result.

Union Cold Drawn Steels are the outcome of 47 years of effort to produce bars best suited for automatic screw machine production. Screw steels, common carbon steels and the alloys have all been improved in machinability.

Promote Efficiency . . WITH UNION COLD DRAWN STEELS

UNION DRAWN STEEL CO., MASSILLON, OHIO

Manufacturers of Efficiency Steels

SUBSIDIARY OF

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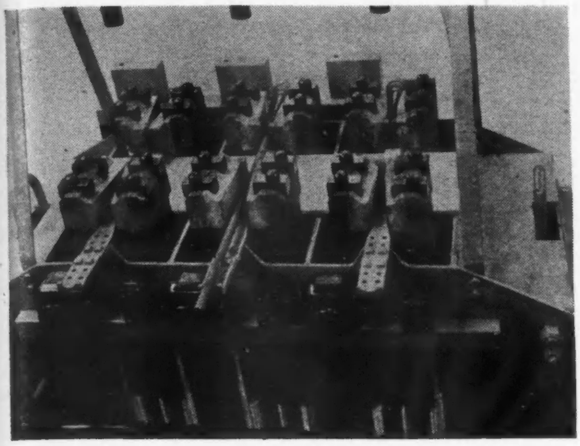


a.c.f. forging heater

The Horizons of Business

(*Continued from page* 741)

may be an important if not the principal reason for this.

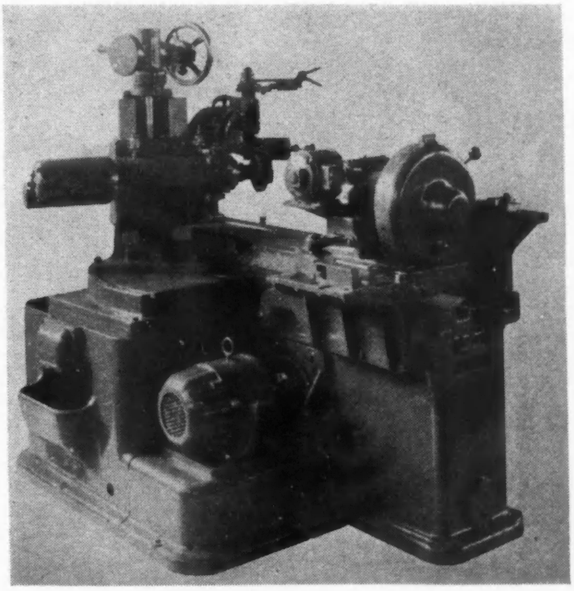
Light from the Land

Agriculture throws an additional light upon this problem. This Administration has gone further in its efforts to help the farmer than any other. The facts are well known. Under government direction pigs were killed, cotton plowed under, acreage kept idle and hundreds of millions distributed to farmers to compensate them for cooperation. The processing tax was levied upon consumption to foot the bill. While this was going on the position of the farmer improved. The question now is "Did this improvement take place be-

mobile plants for making steering drag links. Equipped with "Electric eyes" for temperature control, underheating and overheating are said to be guarded against. This heater will handle stock from 5/16 to 2½ inch diameter.

Fitchburg Has New Spline Shaft Grinder

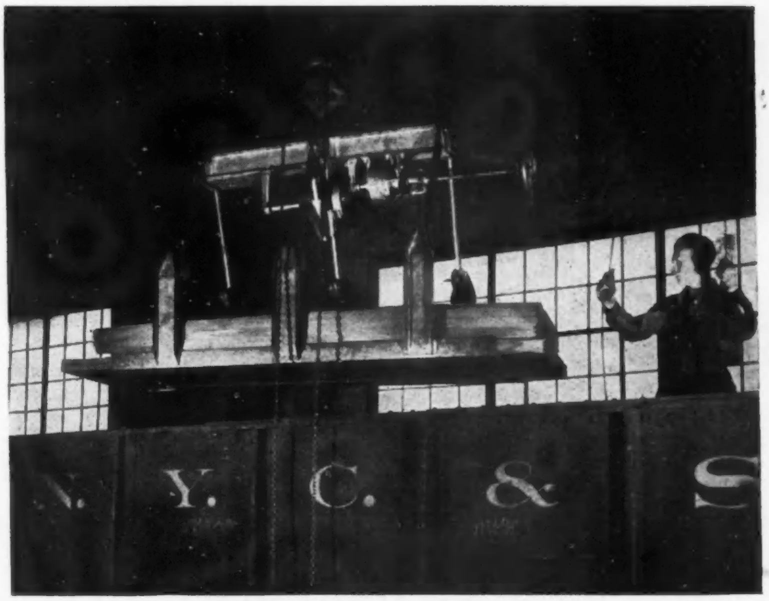
The new Fitchburg grinder can be supplied with a headstock for either straight, or right- and left-hand helical splines or both. The helical lead is controlled by an adjustable sine bar to a maximum of 20 deg. lead angle and rotated by a double preloaded rack and pinion to remove all back lash. An index plate is mounted at the left end of the headstock, where it can easily be changed. A standard 12-key plate is provided which will take care of 12, 8, 6, 4, 3 or 2 spline shafts by means of inserts in the index notches. This machine employs three electric motor drives, one for the oil pump, one for the spindle and one for indexing. The Fitchburg Grinding Machine Corp. is located at Fitchburg, Mass.



Rear view Fitchburg grinder

Sheet Steel Easily Handled

Sheet steel can be handled by the pack, several tons at a time, with the C-F sheet lifter, made by the Cullen-Friestedt Co. of Chicago. Infinite opening and closing adjustment of the jaws within their extreme positions is said to be possible with the type of jaw control mechanism employed. This feature makes it possible to handle any size sheets within the range of the equipment. Opening and closing the lifter are accomplished by rotating the control wheel at the end, placed there so that the operator does not have to work on top of or between the piles of steel. The C-F lifter is also being used for handling engine cylinder blocks.



One man operation with C-F lifter

cause of the foregoing measures or in spite of them?" During the first quarter of 1936 no processing taxes were in force. Benefit and rental payments to the farmer were practically negligible. In other words all the aforementioned measures were in suspense. Cash income from sale of farm products in this period was 20 per cent better than in the corresponding period of the previous year.

Summary

The automobile industry, defying the new theories of the day, is performing prodigies of recovery. For every billion dollars of current national income the country is buying 19 per cent more cars than it did in 1929.

Construction disappoints observers and is doing most poorly in the metropolitan districts of Chicago and New York. It is here that the curious high cost theories of the day are vigorously applied.

Agriculture at great cost shows some improvement during 1934 and 1935. When "aid" based upon the theory of artificial scarcity and higher cost is suspended the consumption of farm products mounts and farm income leaps ahead.

The lesson seems reasonably clear.

Just Among Ourselves

(*Continued from page* 723)

"Our reading and interpretation of the S.A.E. charter indicates that one of its prime purposes is to encourage just such frank discussion of technical problems affecting the S.A.E. membership. On the other hand, we see no provision in the charter enabling the S.A.E. to assume the responsibilities incurred in establishing a commercial grading system covering products not encompassed in the automotive manufacturing field, and establishing this system so as to affect the buying habits of the public. These responsibilities have to do with proper protection of the public, for which the S.A.E. has, in our opinion, established no adequate machinery; and proper protection of every separate interest within the industry whose products are thus graded — and there is ample latitude for free and open discussion of this obligation.

"The grading of petroleum products and all matters pertinent to that process have to do with our business and the business of some 100,000 dealers who represent us faithfully in the domestic market. These dealers have seen one-third of their motor oil gallonage pass out of their natural channels of distribution into channels not normal to the petroleum business since the S.A.E. grading system was inaugurated; and are facing selling costs today 50 per cent higher than they were five years ago, to which the loss of this motor oil volume is a contributing cause.

"Socony-Vacuum is playing no games with the interests of these dealers; we feel perfectly free to speak out at any time against any arbitrarily imposed marketing condition — such as the S.A.E. grading system—which limits the opportunities or otherwise affects the welfare of these dealers."—*Signed:* E. F. HALLOCK.

Zenith Carburetor Company of France reports an important order from the Air Service for Stromberg carburetors, for which it has secured the European representation. A new type of carburetor, which has quite unusual characteristics, is being subjected to tests by a certain number of squadrons at present. (This probably refers to the automatic-mixture-control carburetor described in AUTOMOTIVE INDUSTRIES of May 2.)